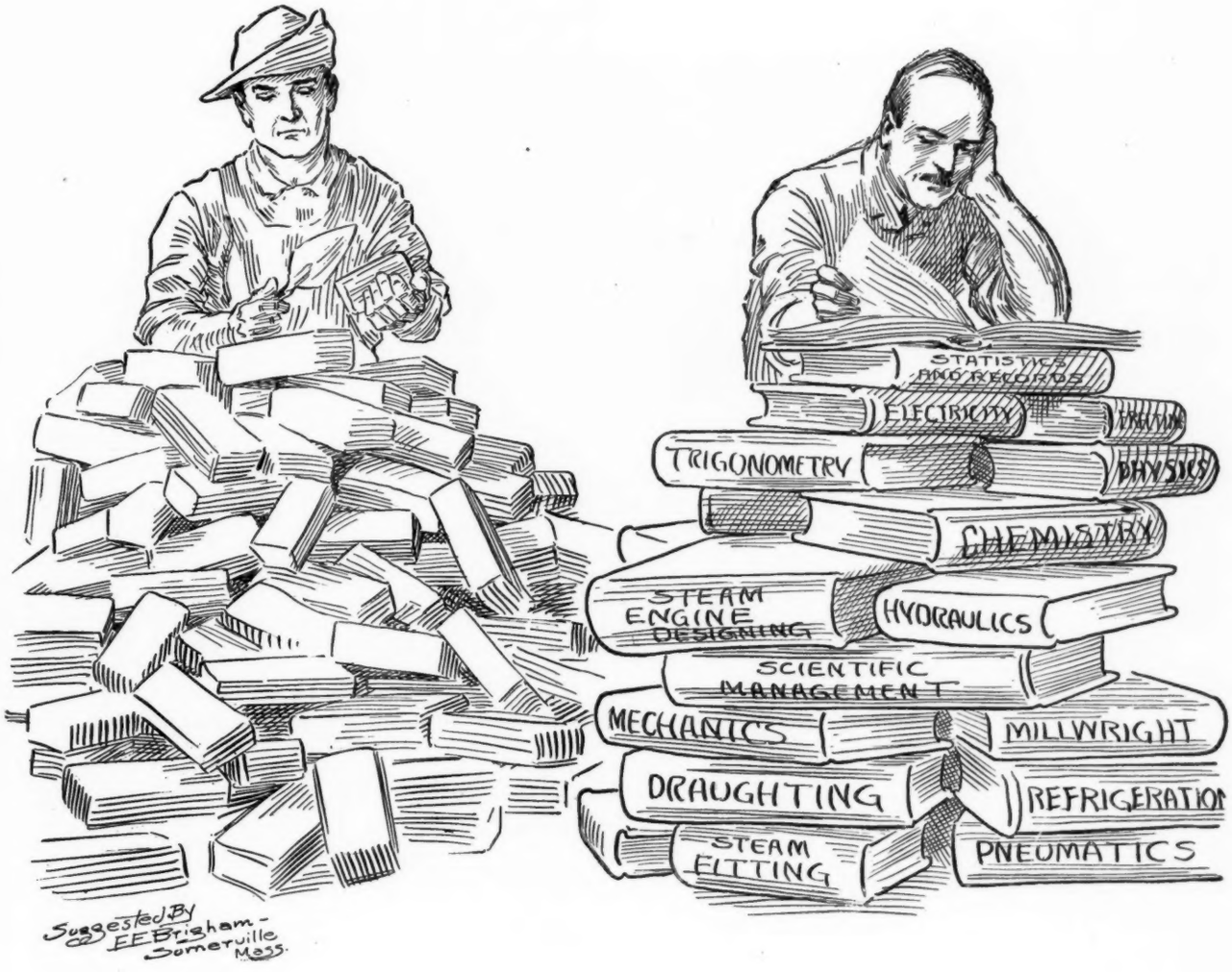
POWER

Vol. 38 NEW YORK, DECEMBER 9, 1913 No. 24

The Materials They Build With



IS THEIR COMPENSATION IN PROPORTION?

Tropical Feed-Water Filter Plant

By C. Carlton Semple

SYNOPSIS—Description of a feed-water filter plant in the tropics, made necessary by the decomposition of rock and organic matter from decaying vegetation. The filter consisted of three tanks in which suitable filtering material was placed.

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One of the perplexing problems to be solved in steam power-plant practice in the tropical lowlands is that of obtaining a sufficient supply of clean water for the boilers. The solution, however, is generally simple once the underlying principles are fully comprehended.

In most tropical regions, at low elevations, the rainfall is heavy, exceeding 120 in. per annum, and while it frequently rains more or less during eight or nine months of the year, by far the greater part falls in four or five months, usually in downpours of only a few hours' duration. Immediately after such heavy rains the rivers become flooded. The densely wooded, almost impenetrable jungle, would seem to be capable of holding this water for a long time, but the soil, consisting often of the clayey products of rock decomposition, retains moisture practically to the degree of saturation at all times, and the sun never reaches the ground to hasten evaporation. It is the slow seepage of water through the clayey soil that supplies the rivers with the water which flows through them at times of low water level.

It is the slow seepage water that is temporarily retained in the soil and not the rapidly drained flood waters that the engineer has to rely upon for boiler feed. This water remaining in long contact with the decomposed rock of which the soil consists, becomes impregnated with soluble salts, and becomes surcharged with organic matter from decaying vegetation. It also takes up minute particles of rock material. For these reasons boiler-scale troubles are apt to be experienced whether or not there be limestone in the vicinity.

A case in point was experienced by the writer at a mine power plant in Nicaragua, when upon taking charge he found that a 30-hp. locomotive-type boiler which was supposed to be capable of generating enough steam to operate all the machinery in the 100-ton mill, could not supply steam enough to keep more than half the machinery going at full speed.

The first thing to be ascertained was the nature of the scale, which was made up of alternate bands of different thicknesses of red and white material. The red material was granular, the white compact and both very hard. A test with hot and cold strong hydrochloric acid failed to show effervescence, which would have indicated the presence of carbonates, probably of magnesia and lime. The glasses in which these tests were made were left standing over night, and the next morning the scale was found to have dissolved in the acid and to have formed a heavy gelatinous mass, indicating that the scale was made up chiefly of a certain class of minerals held in suspension and not of salts in solution in the water.

This simple test indicated that the remedy and the preventive for the trouble consisted in removing the hard scale already in the boiler and eliminating the fine material from the feed-water supply. The scale was entirely too hard to be removed by any scraping or punching tools that could be operated through the handholes, and to have taken out the tubes would have delayed operation for six weeks, causing a loss in production of $6000 in gold, because no extra tubes were on hand and a new set would have had to be ordered from New Orleans.

Fig. 1. Feed-Water Filter Tanks

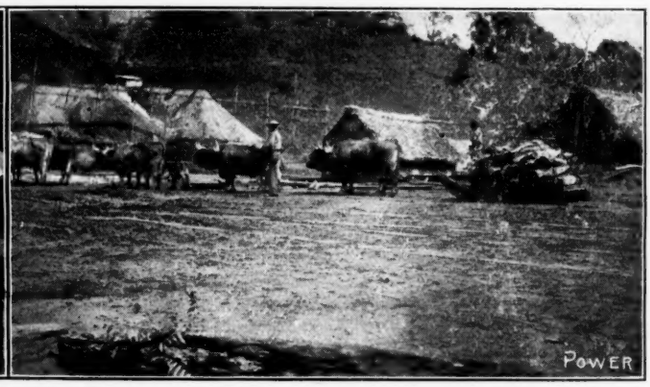

Fig. 2. Hauling Fuel to the Boiler House

Several commercial brands of boiler compounds had previously been tried with indifferent success. After ascertaining the source of the trouble the boiler was filled to a point a few inches above the top row of tubes with water after about one gallon of kerosene had been poured in through one of the handholes. The boiler was then fired up and a pressure of only 30 lb. maintained, while no attempt was made to run the plant. The blowoff was opened for a short period every three hours and the water level reëstablished. After three days the fire was drawn and all the scale that had loosened was removed.

After a second treatment the boiler was placed in regular use and every morning one-half pint of kerosene was added to the feed water. For the first six weeks the fire was drawn every week and the loosened scale removed. A few weeks after this treatment had been started it was possible to run all of the machinery part of the time and half of it all the time at full speed. After two months all of the machinery could be kept running all the time at good speed. After seven months a larger 80-hp. re-

turn-tubular boiler was ready to be put in commission. The small boiler was then retubed, and it was found that practically all of the scale had been removed from between the tubes by the kerosene treatment, but none had been removed from the crown-sheet.

Wood was used for fuel and drawn to the plant on sledges, Fig. 2.

When the new boiler was put into commission the question was raised as to whether or not any corrosion was

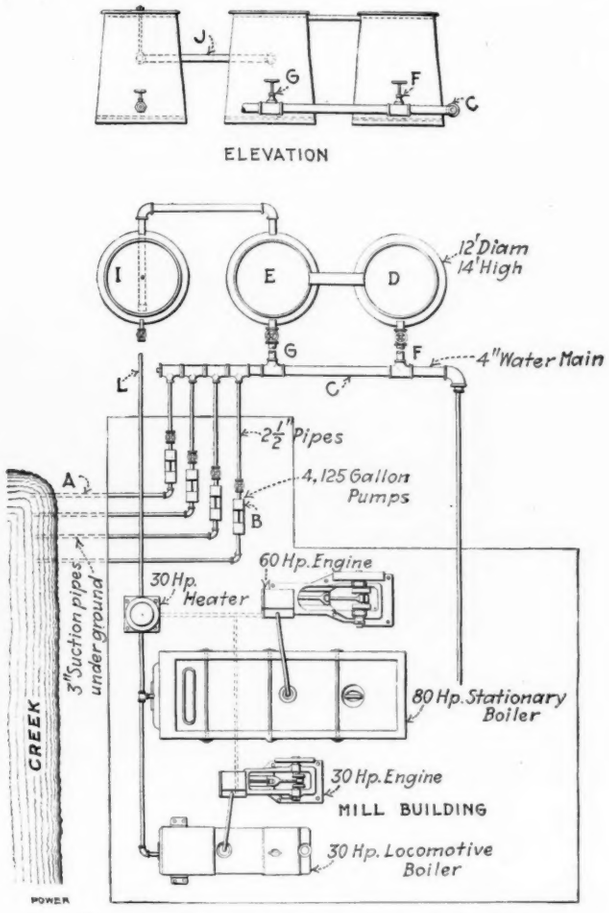

FIG. 3. PIPING OF THE FILTER TANKS

caused by the water. Before firing up, all the outside surfaces of the tubes and the inner side of the boiler shell was rubbed over with flake graphite until a very thin glossy coating covered the metal. This was done not so much with the idea of preventing corrosion as to prevent any scale from adhering. Later when the smaller boiler was retubed no evidence of corrosion could be discerned in the old tubes, nor was any such evidence discovered in either of the boilers at any time thereafter.

Meanwhile a filtering plant was installed to remove the solids in suspension in the water taken from the creek for the boiler-feed supply. This plant was exceedingly simple and required only one 12x14-ft. wooden tank in addition to the two 14,000-gal. tanks that held the mill-water supply, Fig. 1. These were arranged as shown in Fig. 3, in which *A* is the 3-in. suction pipe from the creek to the four pumps; *C* the 4-in. water main that supplied the mill with water and which was connected at one side and near the bottoms of the mill-water tanks *D* and *E*, the connecting pipes being controlled by the valves *G* and *F*. The tanks *E* and *D* were connected at the tops by a trough, about 6 in. deep. The filter tank *I* was connected with the tank *E* by the 4-in. pipe *J*, about midway between the top and bottom of both tanks, and extended across the tank to the opposite side, the end of the pipe within the tank having been plugged and the pipe itself drilled with many ½-in. holes, Fig. 4. The valves on the mill-water main were normally wide open, so that the speed of the pumps had to be so adjusted that all three tanks remained full of water.

Normally the valve *G*, Fig. 3, was closed and the valve *F* left open, so that the water entered the tank *D* at the bottom, rose in it to near the top, thence passed over into the tank *E*, through the trough and rising in the tank *E* to the height of the pipe *J*, flowed into the tank *I*. In rising through the tanks *D* and *E* the coarser solids had ample opportunity to settle, and the sludge thus accumulated on the bottom of those tanks was periodically flushed out through suitable valves.

The bottom of tank *I* was provided with a filter, which, as shown in the section of that tank, Fig. 4, consisted of a grating 1½ in. less in diameter than the diameter of the tank. This grating was made up of 2x2-in. scantling laid upon two sets of timbers 12 in. deep, so that the bottom of the filtering bed was 24 in. above the bottom of the tank. Upon the grating a double layer of thin, white cloth, which in all tropical countries is sold under the name of *manta*, was tacked in place and the grating calked by a piece of hemp rope driven down between the

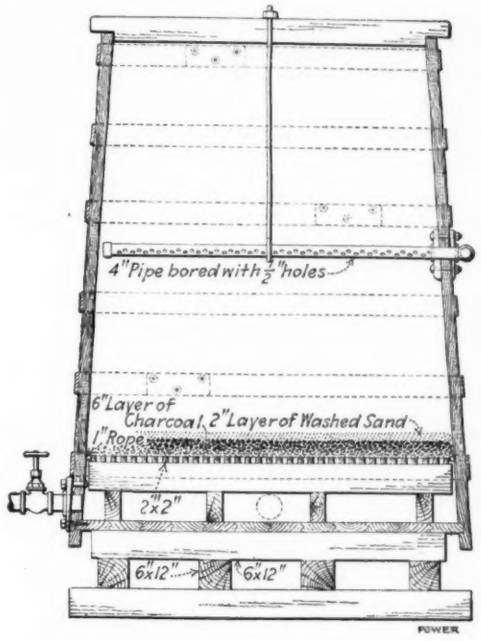

FIG. 4. DETAILS OF CONSTRUCTION

edge of the grating and the sides of the tank. On the cloth was spread a layer of screened charcoal 6 in. deep, the pieces of which were not less than ½ in., nor greater than 2 in. in diameter. Upon the charcoal was spread a layer of washed river-sand containing no particles that would pass a screen with 20 meshes per linear inch. This sand sank into the spaces between the lumps of charcoal, but was, on the average, 2 in. deep. The layer of charcoal was used only to prevent too tight packing of the sand upon the filter cloths.

After the filter has been in use for a week or 10 days

its upper surface becomes coated with a thin gelatinous coating of vegetable growth which, while allowing water to percolate through it, entangled the finest sediment and prevented it from passing through the filter bed.

The water below the filter tank *I*, from which all sediment had been removed and which was crystal clear, was drawn off through the pipe *L* to a 30-hp. feed-water heater, from which all the plates had been removed. All of the exhaust steam from one 60-hp., one 30-hp. engine and four service and four boiler-feed pumps was led into it, heating the feed water to 210 deg. F., before flowing to the pumps. The bottom of the heater was about 2 ft. above the four pumps, so that the water flowed to them by gravity. The feed water was fed to the boiler constantly; one or the other pumps was always in motion night and day, the speed being so regulated that the feed equaled the evaporation.

After this system had been installed no further trouble was experienced from scale. It was the custom to stop operations the first and fifteenth day of each month, which were the mill clean-up days. Then the boilers were blown out and about half an ordinary water bucket of granular material would be found in the bottom. This was probably the salts held in solution in the water and which could, therefore, have passed the filter bed. No scale formed on the plates or tubes, and no corrosion was evident at the end of two years.

At these clean-up times the drain valves on the tanks would be opened to drain off the settled sand and sludge. The sand on the filter beds was removed and a new layer substituted every six months. The cloth in the filter had been in use 18 months when the writer relinquished charge of the work. The heater also served as a sand trap, inasmuch as it would have caught and held all the sand that might have been washed through a hole in the filter cloth and thus have prevented its entering the boiler had such a hole formed.

All the lubricating oil in the exhaust from the engines and pumps entered the feed-water heater, from which the plates and box for removing such oil had been taken out. Consequently much oil must have returned to the boiler and the quantity accumulated steadily for two weeks. A cheap mineral cylinder oil was used, but no trouble was experienced from its presence. On the contrary, the oil was regarded as beneficial rather than detrimental, as it probably caused salts that had been in solution in the water to settle as a granular sand rather than in a compact mass. The filtering capacity of one 12x14-ft., 14,000-gal. filter tank was just sufficient for the two boilers. The water percolates very slowly.

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Modern Boiler-Room Operation*

By W. A. Blonck

SYNOPSIS—Application of the Ohmic-law principle to boiler operation. Opportunities for improving average present-day boiler-plant efficiency by means of suitable instruments enabling operators and chief engineer to know condition of furnace at all times. Two bonus systems that failed and one that was successful.

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The erroneous idea appears to prevail that it takes brain to run an engine room while just brawn is sufficient for the boiler room. This point is brought home upon entering a turbo-generator plant and seeing an equipment of instruments on the generator panel representing an expenditure of from $1000 to $2000. Even the worst operator cannot decrease the efficiency of the prime movers more than about 2 per cent., while in the boiler room the loss in economy due to ignorance or lack of suitable indicating and recording apparatus may amount to as high as 30 per cent., or even more. Yet, in most boiler rooms a steam gage and water glass are the only instruments provided. About 70 per cent. of the cost of operation of most power plants is chargeable to the boiler room, and for the handling of this expenditure the management often employs the lowest grade of labor available, instead of giving inducements to the intelligent workman to stay in the boiler room and handle this expenditure judiciously. Another point for criticism is that in many industrial plants the power-generating expense is charged entirely to overhead expense and the power house is not treated as a separate department, receiving a certain sum every month for the raw material (coal) and giving a finished product (power) with a certain net return. In too many plants the cost data kept consist only of the coal bills and the weekly payroll. No check is made on the weight of the coal received neither is its heat value ascertained nor the evaporation it yields in actual service. And, as more than 70 per cent. of the entire expenditure for power is generally handled in this crude manner, it is no exaggeration to say that from a commercial standpoint the operation of two-thirds of our boiler rooms is to be considered as an economic joke.

As a concrete illustration, consider the horrible example of a smaller size of coal mine. Here an equipment of six very small tubular boilers is erected in the open air, just protected in front by a rain shed; the fire-doors close only partly; the settings are badly cracked; the rear arches have holes through which one could pass his fist; the flue-doors are without a latch, and the stacks are eaten through by corrosion. The duplex pumps employed have leaky valves and piston rings, resulting in a constant roar of exhaust steam passing out at the roof.

When the owner was informed that a simple and inexpensive fixing-up of his plant would result in a saving of 75 per cent. of the coal used, he paid no attention but merely remarked that the operation of the plant cost him nothing except for a little labor as the coal was found right near the ground.

Although this mine owner was prosperous, he certainly suffered from a warped mind and had a kink in his business make-up. He and other members of his class remind me of a saying current among the aristocrats of France just before the crash came at the end of the eighteenth century, which in plain English would run about as follows: "Let us enjoy and waste today, we do not know what tomorrow will bring and we do not care who comes after us."

*Abstract of lecture before Illinois Association No. 28, Chicago, of the National Association of Stationary Engineers, Nov. 1.

Looking at the reverse of this picture, it requires no great strength of imagination to predict that a few centuries hence some college professor at the head of his class will lift an incandescent bulb and make a remark about as follows: "This was the means of light in the twentieth century. It was produced from the energy stored in coal with an efficiency of 0.2 per cent. What would we not give if some of this precious energy had been left for us?"

Steam boilers have been employed for more than 200 years, yet it must be confessed that less is generally known about them than the electrical engineer knows about the practical forms of electricity, although the latter is a development of only about 25 years. In the evolution of his art, the electrical engineer soon realized that a quantitative and qualitative analysis of electrical energy was necessary and thus the Ohmic law soon became a tool easily comprehended by all workers in the art. A standard of measurement analogous to the Ohmic law can be applied to the operation of a boiler furnace. The draft resistance of the fuel bed can well be compared to a resistance in an electric circuit. The pressure or draft loss caused by the fuel bed can easily be compared with the voltage of the electric circuit and the amount of flue gases passing through the boiler can well be compared with the amperage in an electric circuit. This analogy is true to the extent that the amount of flue gases passing through a boiler is in direct proportion to the friction loss through the boiler, and in indirect proportion to the friction loss through the fuel bed.

Any device, such as the Blonck boiler-efficiency meter,* which gives the fireman or water tender information as to the resistance of fuel bed and loss in draft through the boiler, serves at once to show relative boiler output and efficiency.

One pound of coal burned with best efficiency in the Illinois district requires about 20 lb. of air. As the fireman can neither see, smell or hear when the correct amount is being supplied it often happens that four or five times as much is admitted, resulting in the cooling down of the gases and the necessity for a great amount of extra coal for no other purose than to heat the excess air supplied to the furnace and later passed to the chimney without adding one iota to the steam production for which the plant was built.

Then, there is the other possibility of supplying too small an amount of air. This results in incomplete combustion, producing carbon monoxide in the flue gases which has the same effect of lowering efficiency.

The *crux* of the entire combustion problem is to be able to regulate the amount of oxygen or air supply per pound of coal and to be able to tell instantly when the mixture relation changes to one producing waste. The Blonck meter makes the accomplishment of this result possible and by means of adjustable indicators may be set so that even a foreign laborer who cannot understand English can be quickly taught to regulate his furnace with the guidance of the meter.

To the ambitious engineer this and similar instruments are as important in the boiler room as the steam-engine indicator in the engine room, except that they have the added advantage that they give a continuous indication of the combustion process.

*Described in our issue of Dec. 24, 1912, and mentioned in that of Feb. 11, 1913.

As far as can be determined, there are two ways of getting the closer attention of the firemen. The first is the well known bonus system, and the second is to furnish the fireman proof that by firing correctly, which he can do with the assistance of proper instruments, he has to shovel less coal or can do better work with the exertion of less effort.

Bonus systems do not always work, as the following will indicate. A system was instituted in a high-grade plant of the Central West. The plant contained eight boilers, six being operated for average week-day loads. The coal used contained 10,000 B.t.u. per lb. and the firemen were shown how to keep a nice average of 8 per cent. CO_2. The bonus was to be $1 a week per man for each shift of firemen keeping an average of 8 per cent. and 25c. more for each additional ½ per cent. Inside of a week the bonus had boosted the CO_2 to 10 and 11 per cent. An investigation showed that it was now necessary to run seven boilers instead of six, and close coal and water records disclosed the fact that the evaporation per pound of coal had decreased instead of increased. The men simply worked for the bonus by keeping the damper partly closed and carrying very heavy fuel beds on the grates, thus reducing the rate of combustion per square foot of grate area and introducing the added losses due to greater radiation and the escape of unburned combustible gases. The system was abandoned as a consequence of this discovery.

In another instance a system was installed in a high-grade plant in the East having an accurate coal-weighing and water-measuring equipment. Each shift saw its previous day's record on a blackboard conspicuously located in the boiler room. The record simply gave total pounds of water evaporated, total pounds of coal burned and pounds of water evaporated per pound of coal. The feed-water temperature was practically constant for the three shifts. With 14,000 B.t.u. coal the bonuses were awarded for average evaporation of 8.5 or more pounds of water per pound of coal. The rivalry among the three shifts brought this value in a few weeks up to more than 9.75, and as that gave rise to suspicion, a watch was set, and it was found that this bonus system inspired the men to open the mud drums and blow frequently and generously to the sewer. As it did not seem advisable to provide locks and keys for the blowoff cocks, this system had also to be abandoned.

A bonus system which thus far has been free from temptations for the men to be dishonest is now being successfully operated in several plants of the Central West. Blonck boiler-efficiency meters of the indicating type are mounted on the boiler fronts and units of the recording type are installed under lock and key in the boiler-room foreman's office. As the recorders show graphically the relation at every instant between furnace resistance and boiler resistance, or in its last analysis, the amount of air admitted per pound of coal delivered to the grate, there is no chance for deception regarding the actual handling of the furnaces with its consequences relating to furnace efficiency and boiler capacity.

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Mention of the fact that the gas-engine-driven exhausters, Fig. 9, of the Flatbush Gas-Electric Station article, Nov. 18 issue, were furnished by the Connersville Blower Co., was inadvertently omitted.

Sullivan Angle-Compound Air Compressor

As shown in the illustrations, Figs. 1 and 2, the angle-compound class "WJ3" air compressor has its low-pressure or intake cylinder in a horizontal plane, with the high-pressure cylinder set vertically, on the end of the horizontal frame. Both pistons are actuated by a single crank, and both sets of valve-gears by a single-eccentric pin. The driving pulley or motor is mounted at one side, on an extension of the crankshaft.

The main frame in this type of angle-compound compressor is horizontal, and supports the entire machine. To one end is attached the low-pressure cylinder and on the other is bolted an upright pedestal, which carries the vertical or high-pressure cylinder. This main frame is of the heavy-duty, Tangye pattern, with bored guides for the low-pressure crosshead. There are openings in the sides, to afford access. The bottom is solid and forms a reservoir for oil.

consisting of a babbitted box, carried in a heavy pillow block upon a sole plate bolted to the foundation. Set-screws and wedges permit adjustment both vertically and horizontally, so that this bearing may always be kept in correct alignment with the crankshaft bearings.

The band flywheel is of sufficient weight to give steady motion to the compressor, at its rated speed; it is made in halves.

When desired, the compressor may be driven by an electric motor mounted directly on the crankshaft. In this case the regular belt pulley is replaced by a heavy square-rimmed flywheel. A special crankshaft is supplied, of sufficient length to properly accommodate the electric motor.

Both low- and high-pressure cylinders are made with separate liners forced into the main castings, the spaces between the liners and cylinder castings forming the water jackets. The air passages in the cylinder casting cover the entire area outside of the jackets, the inlet and discharge sides being separated by longitudinal parti-

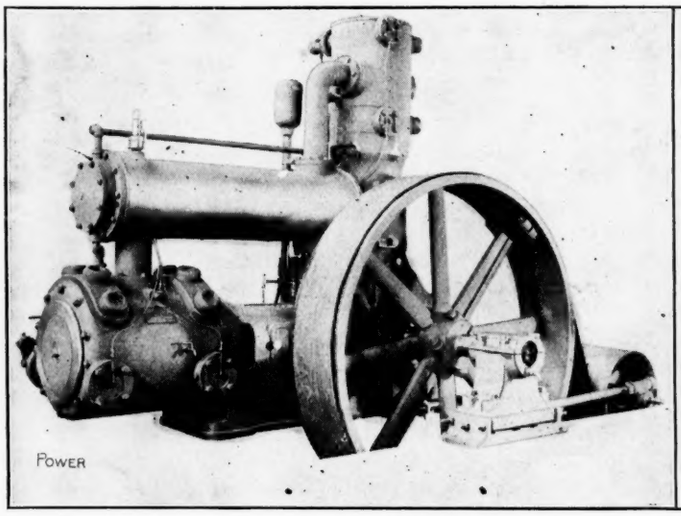

FIG. 1. VIEW FROM AIR END OF THE COMPRESSOR

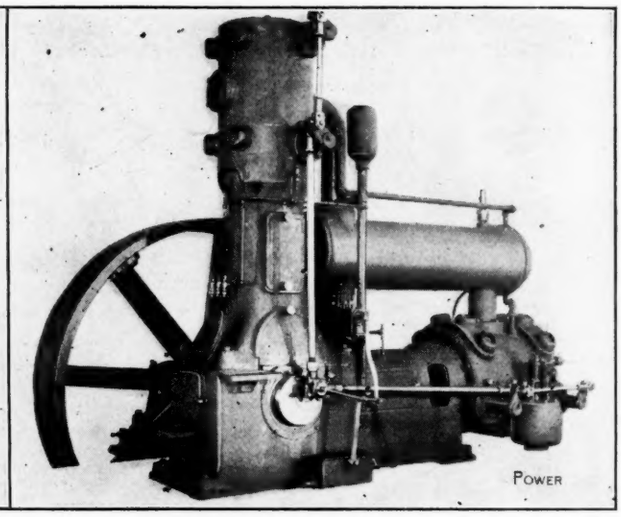

FIG. 2. VIEW FROM STEAM END OF THE COMPRESSOR

The vertical frame or pedestal is of similar design and has a broad base secured by heavy bolts to the top of the front end of the main frame.

The main bearings are made in four parts, of cast iron, lined with babbitt, with setscrew adjustment, and so designed that all four parts may be taken out without removing the main shaft.

The connecting-rods are forged from openhearth-steel billets, with marine-type boxes on the crankpin ends, lined with babbitt.

The crankshaft is a heavy, openhearth-steel forging, of the center-crank type. The crankpin is of a proper length to accommodate both connecting-rod boxes on it side by side. A heavy cast-iron counterweight is bolted to each crank cheek, equaling the whole weight of the reciprocating parts of either the high- or low-pressure member. The centrifugal effect of these weights neutralizes the inertia of both sets of reciprocating parts, so that the compressor runs at full-rated speed without perceptible vibration.

This crankshaft extends from one side of the machine to receive the driving pulley or motor, and in all except the smallest sizes, is provided with an outboard bearing,

tions on the sides of the cylinders. The surface on the outer side of the jacket walls provides considerable cooling area in addition to that of the intercooler.

The air-inlet valves are of the Corliss type, of ample area to fill the cylinder at atmospheric pressure when the compressor runs at maximum speed. The air-inlet valves are driven by steel valve stems equipped with collars, with ground joints between these collars and the bonnets, to prevent leakage of air around the stems. The stems derive their motion, through cast-iron rocker-arms keyed to them, from a single crankpin, attached to a small disk keyed to the end of the main crankshaft opposite the flywheel. The connection rods for operating the inlet valves are placed side by side on this pin, one rod reaching horizontally to the low-pressure valves, and one vertically to the high-pressure valves. All valve-gear connection rods have adjustable bronze heads for taking up wear.

The air-discharge valves are of the poppet type, internally guided on cast-iron plugs, and held to their seats by light steel springs; they seat in bronze cages, readily removable by unscrewing the valve plugs, and are sufficient in number to provide ample area for the escape of the compressed air from the cylinders. They are set,

with their cages, in ports or pockets, arranged radially in the air-cylinder heads, and readily accessible for inspection or removal. As these valves act in a direction radial to the axis of the cylinder, they avoid losses in efficiency due to clearance space to the greatest possible degree. There are no long ports or pockets leading to them, in which air is trapped after compression instead of being expelled from the cylinder.

The intercooler, for removing the heat of compression in the air from the low-pressure cylinder, cylindrical cast-iron shell containing an amount of cooling surface sufficient to produce thorough cooling of the compressed air. It is located immediately over the low-pressure cylinder and frame, and has flanged inlet and outlet openings, and cast-iron flanged connections between it and the high- and low-pressure air cylinders. It is supported on its inner end by a hollow, cast-iron flanged leg, into which any accumulation of water or oil will drain. This water or oil may be blown off through a drain cock, provided at the bottom. A pop safety valve, attached to an opening on top of the intercooler, prevents unsafe pressure in the intercooler or low-pressure cylinder.

The intercooling surface consists of a nest of aluminum tubes through which the cooling water circulates, entering at one end, traversing one-half the tubes, and returning through the remainder. The ends of these tubes are expanded into two headers, the outer header being bolted against a packed joint on the outer end of the intercooler body, while the other header, inside the intercooler body, is free to move with the expansion or contraction of the tubes. Suitable baffle-plates, in the interior of the body, are so arranged that the air, in flowing through it, will be compelled to pass three times across the tubes, thus insuring a thorough cooling effect. By removing the bolts securing the outer header, the whole nest of tubes with the headers, may be withdrawn from the base or shell for inspection or repair. Both headers have removable covers which give access to the ends of the tubes for the removal of sediment or for the insertion of new tubes when necessary.

The crankshaft bearings, crank and crosshead pins and crosshead guides of both high- and low-pressure members, are supplied with steam lubrication. From the main oil reservoir, in the bottom of the horizontal main frame, underneath the crankshaft, a small plunger pump, driven from connections attached to the air valve-gear, and with all of its working parts submerged in oil, delivers oil to a reservoir at the top of a standpipe, high enough to insure the delivery to the highest point at which lubrication is needed. From this reservoir oil flows to the points specified. The amount of oil flowing to each point is regulated by adjustable sight-feed connections. The pump is designed to pump an amount of oil greater than maximum requirements, and the excess from the overhead reservoir is returned by an overflow to the main reservoir in the horizontal frame. After the oil has passed through the various bearings, it flows back to the main reservoir to be used again. The air cylinder and rolling inlet valves are oiled from a separate five-feed positive oil pump of special design, driven from the air valve-gear. Each feed may be regulated separately.

The rate of feed of oil, to all points lubricated, may be observed by the operator from the engine-room floor. All working joints in the air valve-gear are lubricated with grease cups. The outboard bearing supporting the end of the crankshaft is independently lubricated by a supply of oil contained in a well underneath the bearing to which it is delivered by ring oilers.

The water circulation for the cylinders and intercooler has but one inlet and one outlet. Entering at the bottom of the low-pressure cylinder, water passes thence through the intercooler and high-pressure cylinder, leaving the latter at the top. This arrangement provides a positive circulation, with no danger of entrapping air in the water spaces.

An unloading valve can be provided for cutting off the supply of air to the compressor, when the receiver pressure has reached the desired limit. It is attached to the main inlet opening on the low-pressure cylinder, and is of the total closure pattern. This apparatus consists of a double-beat valve, placed on the air-inlet duct, and controlled by air pressure from the air receiver. The valve is set to shut off all the incoming air from the compressor,

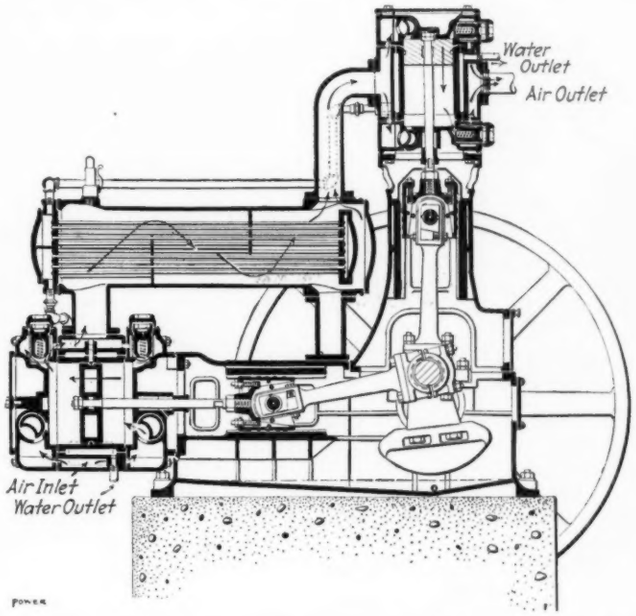

FIG. 3. SECTION THROUGH THE ANGLE-COMPOUND AIR COMPRESSOR

when the receiver pressure rises above a point; that is, when the demand for air drops away. The compressor then runs under no load, except friction, compressing no air, and reducing the consumption of power to a very low factor.

When the demand for air begins once more, that is, when the pressure in the receiver falls below the point at which the unloading device is set to act, the valve again opens fully, and the compressor automatically resumes its entire load, until the demand for air again ceases, when the cycle of operation, just described, is repeated.

This unloading valve may be adjusted by means of a weight, lever and springs, to maintain any desired pressure in the air receiver. Its action is prompt and positive, and it does not throttle or wire-draw the air in its passage to the intake cylinder. The passage is either fully open or tightly closed. At the same time, the action of this device is gradual and smooth, so that the load is thrown on evenly, without sudden shocks and consequent fluctuations and peaks in the power-consumption line.

This air compressor, manufactured by the Sullivan Machinery Co., Peoples Gas Bldg., Chicago, Ill., should be especially attractive to power plants for all sorts of manufacturing service, on account of the small floor space which it occupies, its simplicity, high overall efficiency, low factors of care, attention and repair, and flexibility of the driving element.

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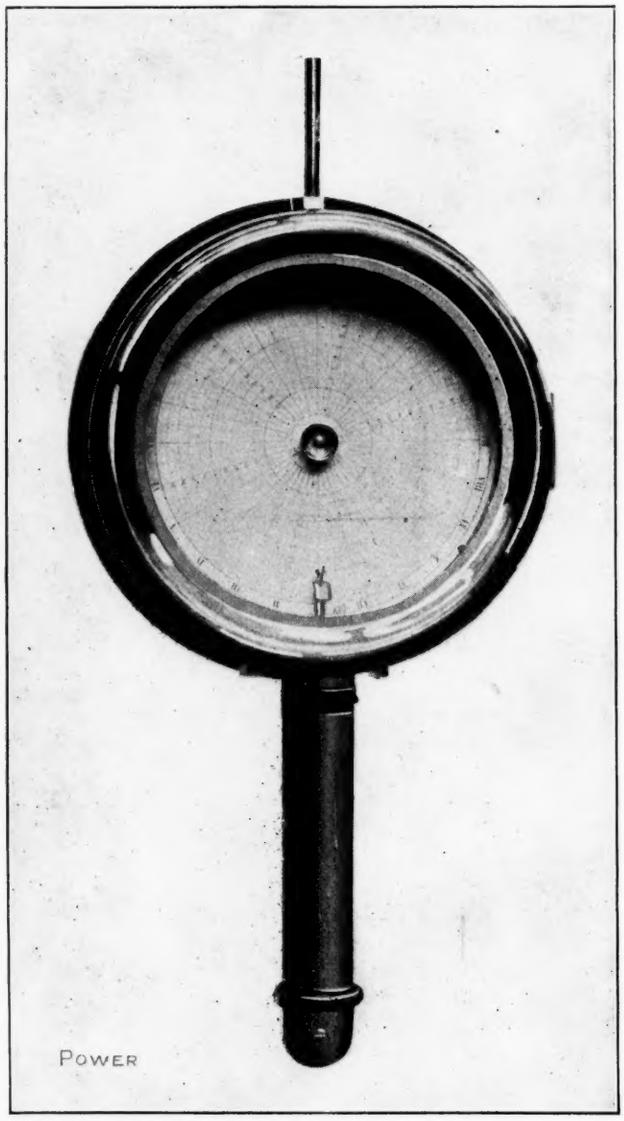
Uehling Vacuum Recorder

The Uehling vacuum recorder is an instrument of hydrostatic type. The pen is actuated by a float resting on mercury contained in a cylindrical float chamber, secured to the lower side of the clock case. Connected with this chamber is a steel tube of the proper length to contain a column of mercury to balance the atmospheric pressure.



UEHLING VACUUM RECORDER

The cross-sectional areas of the float chamber and pressure tube are such that the pen moves over the full width of the available chart for the range of vacuum to be recorded.

The Uehling Instrument Co., Passaic, N. J., makes these recorders for three ranges, viz., from 0-30, 20-30 and 25-30 in. The advantage of this is evident since a very open scale is obtained where the readings are of importance.

The illustration shows a vacuum recorder with a range from 20-30 in. of mercury.

❋

Influence of Soot on Boiler Economy

BY H. D. FISHER

The writer has been engaged in boiler-plant work for a number of years, and has made a careful study of the accumulation of soot and methods for removing it, also its effects, both by boiler tests and inspections of boilers, when they were out of service, on which various methods of cleaning were used.

Recently the writer ran tests on a boiler equipped with a tube-blowing device to determine its effect on boiler economy. The water-tube boiler was 400 hp. capacity, 21 ft. wide by 9 ft. high, 4-in. by 18-ft. tubes, three 36-in. by 20-ft. 2-in. drums and a superheater with 439 sq.ft. of surface. It was hand fired with a mixture of Pennsylvania bituminous coal and screenings in the proportion of about one to three, on a rocking grate 12 ft. wide by 7 ft. 4 in. long, or 88 sq.ft. area. Test *A* was run one week after the tubes had been thoroughly swept and the boiler operated as usual without blowing or cleaning the tubes in any way. Test *B* was run two weeks after the test *A* and one week after the tubes had been swept, the boiler being operated as usual and the tubes blown daily. The tests were of two-hour duration and were started and stopped by the alternate method.

Number of Test	A	B
Steam pressure gage, lb.	130	131
Temperature feed water, deg.	208	193
Temperature gases leaving boiler, deg. F.	437	470
Temperature superheated steam, deg. F.	424	435
Draft at boiler damper, in. water	0.50	0.46
Weight coal as fired, lb.	13,207	14,604
Per cent. moisture in coal	2.74	1.54
Total ash and refuse, lb.	2835	3558
Coal per sq.ft. grate per hr., lb.	15.0	16.6
Total water fed to boiler, lb.	111,419	121,499
Water evaporated per lb. coal, lb.	8.43	8.32
Per cent. rated horsepower developed	88	98
Heating value of coal per lb.	13,057	13,410
Efficiency of boiler grate, per cent.	67.9	66.7
Loss due to latent heat of water, per cent.	2.3	2.2
Loss in products of combustion, per cent.	6.9	7.2
Loss in air excess, per cent.	6.3	7.2
Loss due to unburned carbon monoxide, per cent.	0.6	1.2
Loss due to unburned carbon in ashpit	6.7	5.3
Radiation and unaccounted losses	9.3	10.2
	100.0	100.0

Neither from these tests nor the continuous operating results of the plant could any improvement in operating results be noted.

A particularly bad feature of all forms of soot-blowing apparatus which require a number of pipes piercing the boiler side walls, especially if they are installed after the boiler setting is erected, is the cracking up of the brickwork and the amount of air leakage this allows. In some tests on 302-hp. water-tube boilers with hand-fired, flat grates, burning a mixture of two parts Pocahontas to one part screenings, it was found, from gas samples taken over the fire in the first pass, that there was 11.6 per cent. CO_2, corresponding to 77 per cent. excess air, while in the back connection simultaneous samples showed only 5.8 per cent. CO_2, corresponding to 280 per cent. excess air, or that more cold air was leaking in through the boiler walls than was coming up through the grate; they were operating a part of the boiler as an air-cooled condenser.

The worst feature, however, of all forms of fixed-jet apparatus is that they cannot be spaced close enough to effectively clean the tubes. The fine yellow dust and ash which carries over from the grate, coheres very strongly and requires a strong jet at a short distance from the nozzle to remove it.

Some large horizontal baffled water-tube boilers in one of the big Philadelphia electric-generating stations have a most elaborate system of fixed steam jets, but in practice it has been found that these will do little more than keep the soot from accumulating in large heaps in the corners of the baffles and keep the soot off the adjacent rows of tubes.

Blowing tubes with a hand pipe is usually ineffective, as the alleys are too narrow to allow a long enough pipe to reach clear across the boiler tubes, not to mention its awkwardness. One case showed this very clearly. A 508-hp. water-tube boiler, 18 ft. wide by 14 ft. high, equipped with a stoker 11 ft. wide and 12 grates long was being used for making competitive tests of semi-bituminous coals. The same man fired all the tests which were run at about the same boiler horsepower, but it was noticed that, although the tubes were blown every day, the flue temperature kept steadily increasing.

The tests were started with the boiler practically new and, owing to alterations in the rest of the boiler plant, it was impossible to take it out of service for about three months, during which time the flue temperature, with the boiler running very close to rating, rose from about 450 to 600 deg. F.

When the boiler was finally cut out of the line it was found that about one-third of the boiler nearest the inner wall was almost solid with a fine, yellow ash and a thorough sweeping brought down over a ton of it. In this case the alley was too narrow to use more than a 6-ft. pipe.

A very effective scheme in cases like this is that used by one of the large New York companies. The blowing pipe is made of two lengths which will conveniently work in the alley, joined by a swing joint, similar to those used in gas jets. The pipe is first entered with the joint bent at right angles, when this first portion of the tubes has been thoroughly covered, the joint is straightened and the back tubes can then be reached.

The general opinion seems to be, among large steam users, that while blowing tubes will help to a certain extent the only satisfactory way to keep the fire side of boilers clean is to take them out of service every so often and brush down all soot and ash off the tubes. This is even a meaner job than blowing tubes, but does not have to be done so often, and can be done with a cheaper grade of labor.

Care in this direction is amply repaid, for, with good firing, a reduction of 50 deg. F. in the flue temperature will mean a saving of 3 per cent. in the coal bill and where firing is poorer and correspondingly larger quantities of air are passing up the stack the savings will be even larger.

It is along this line and that of keeping brickwork, etc., in good condition and free from air leaks that the average engineer can do most to increase the efficiency of his plant, as they require no elaborate testing outfit, but can be seen and remedied by any man who is willing to take the trouble.

Condenser-Tube Corrosion—II

Comparison of Practical and Laboratory Results

The agreement between the two methods of work is striking. In both, the order in which the tubes resist dezincification at elevated temperatures has been found to be precisely the same. It is unfortunate that no strictly quantitative expression can be obtained to represent the relative merit of the tubes as regards resistance to dezincification. In the case of the experiment with the condenser plant the authors have been obliged to rely upon mere inspection of the tubes. Nevertheless, there can be no doubt that the 70: 29: 1 and 70: 28: 2 tubes are more resistant than the 70: 30 brass, and this more than the Muntz metal.

The supreme importance of temperature, which had been clearly indicated by the laboratory work, was amply confirmed by the large-scale test In each of the four sets of three tubes the topmost was the most severely attacked, and a study of the details of the construction of the condenser will show clearly that the top tube must have been the most highly heated of each set. On the other hand, the bottom tubes of each set must have been subjected to a distinctly lower temperature than the others, and as a result the bottom tubes in two cases have not been attacked at all, and in the other two cases the attack is less than that in the case of the higher tubes. Both sets of tests bring out the fact that the locality in which dezincification occurs is not determined by the electrochemical action of carbon or any other foreign particles settling on the tubes. It is due to a chemical action which becomes the more pronounced as the temperature is raised from the ordinary temperature to 122 deg. F., and probably higher, though the Admiralty tube must possibly be excepted from this statement. This action takes place under conditions which exclude the possibility of the settling on the tubes of any substance not derived directly from the tubes themselves.

Dezincification appears to be a phenomenon inherent in alloys of the brass type, and to be more pronounced the higher the percentage of zinc in the alloy. It starts at certain points on the tubes and spreads outward from them, until, in time, the whole tube would become dezincified. A distinct relation has been found between the presence of firmly adherent oxychloride and the spots or areas of dezincification. It has been observed in tubes corroded under conditions of practical work, as well as in the experimental condenser test. Direct evidence has been obtained in the laboratory as to the evil effect of this substance. The authors believe it to be both a result and an accelerating cause of dezincification.

The Protection of Condenser Tubes

The methods in use for the protection of condenser tubes are electro-chemical in nature; they depend either on the use of some metal, such as zinc, iron, or aluminum or its alloys, which is electro-positive to brass, and which will consequently set up an electrical current when both are connected together and immersed in sea water; or on the use of a dynamo to pass the current to the brass. In principle the two methods are identical—namely, that of making brass which it is desired to protect, a cathode at which there will be a tendency for the liberation of hydrogen, while oxygen will tend to be set free at the anode. This anode may consist of any of the metals mentioned above. The idea is to concentrate corrosion on the anode, which is sacrificed to protect the cathode.

The metal zinc has been largely employed for anodes, both for the protection of boilers and condensers. In the case of the latter, it is placed in the water-ends and is securely bolted to the tube plates. At first sight it would appear to be a more suitable metal than iron, since it is more electro-positive, but in practice this does not prove to be the case. There appear to be two reasons for this. The first is that the zinc gradually becomes covered with a fairly adherent layer of oxide, which itself is electro-negative to brass, and is a poor conductor of electricity. Thus the protective action of the zinc soon ceases, and might even be reversed but for the poor conducting properties of the oxide. The second reason is that the consumption of zinc is found to be great—far greater than that demanded by the requirements of electro-

chemical protection. It seems probable that the zinc is subject to auto-corrosion due to the action of the zinc-oxychloride which adheres to the metal.

For the protection of condensers zinc has been largely replaced by iron, which is not only cheaper, but more efficacious. The iron is used generally in the form of slabs, which are placed in the water-ends of the condenser, and are attached by bolts to the tube-plates.

If any electro-chemical action is to occur, it is obviously necessary to insure that the connection between the iron slabs and the tube-plate be thoroughly satisfactory. It is, of course, possible that the mere presence of iron slabs in the water-ends of a condenser might give rise to a certain amount of protection by depriving the water of a large proportion of its oxygen, which will go to form rust. If this be so, no special care need be taken to insure satisfactory electrical connections. To test this point, the following experiments were made:

Three pieces of 70:30 brass tube were taken, together with three pieces of wrought iron. On to one tube and one piece of iron lengths of copper wire were soldered. These were weighed separately, and then the copper wires were connected together, so as to insure good electrical contact, yet they could be separated again for weighing purposes. The tube and iron were then immersed in a beaker containing 1½ liters of sea water. One of the other pieces of brass tube was weighed, and suspended in another beaker at a depth of 2 in. from the surface. At a distance of ½ in. above it a weighed piece of wrought iron was arranged. Thus there was no electrical connection between them. The other length of tube and iron strip were similarly immersed in a third beaker through which a stream of air was kept bubbling. The air was introduced at the bottom of the beaker. All the beakers were then placed in a thermostat at 122 deg. F. The object of carrying out the experiments at this temperature instead of at the laboratory temperature, was to ascertain whether electro-chemical protection would prevent selective corrosion, which is particularly active at this temperature. At the end of seven and 14 days all the pieces of metal were weighed. The tube which was in electrical contact with the iron was completely protected, and showed no loss of weight. The surface appeared quite bright and unoxidized, and no sign of pitting could be seen, although previous experiments show that it occurs normally in seven days at this temperature. On close examination the protected brass tube was found to be covered with a uniform thin transparent layer of some substance which could only be removed by scraping. The layer was of about the thickness of tissue paper, and proved to consist of calcium carbonate. The role of this layer evidently deserves careful consideration in any discussion on the mechanism of protection.

Electrical Contact Necessary for Protection

Neither of the other tubes was completely protected, proving that electrical contact is necessary. The question then arises, how can electrical contact protect parts of the tubes remote from the contact, i.e., why does not all the current generated pass between the iron anode and the part of the tube near it?

It is difficult to see how iron slabs in the water-ends can protect the middle of the condenser.

The same difficulty is met with in considering the mode of protection by a current generated by a dynamo, as in the Cumberland process. Of course, in this case a much larger current can be used, and it can be increased at will until it is effective, but the authors have been informed by Mr. Cumberland that in normal cases 2 amp. per 1000 sq.ft. of tube surface is sufficient for protection, and where such a small average current is used the amount conveyed by the most remote foot of tube must be small. It seems certain that some other factor must operate to assist protection.

To test the matter the following experiment was made: In a glass vessel three 70:30 boiler tubes were placed at varying distances from an iron anode, the distances being ½ in., 10 in. and 20 in. respectively, but as the last was twice the area of the first, it should receive one-twentieth the protective current, or what the middle of a condenser tube should receive.

At the end of three weeks the tubes were examined. Each was covered with a thin translucent layer of calcium carbonate. Under this the brass was found to be unattacked. A fourth test piece not connected was found greatly attacked, and without any protective coating. It becomes evident that when iron anodes are used for protection, that the greater part of the protective current passes at first by the shortest path and protects only the parts near the iron. These soon become covered with calcium carbonate, greatly increasing the local resistance, and the current passes to more remote parts, and covers them with the carbonate film, which thus gradually creeps along the tube. The extreme distance over which protection can be extended is conditioned by the relative resistance of the calcium-carbonate layer, and the increasing resistance of the more remote water circuits. The part played by this film in electro-chemical protection must be immensely important.

How Electro-Chemical Protection May Be Destroyed

Electro-chemical protection may cease to be effective through: Breakdown in the electrical connections; by mechanical injury to the calcium-carbonate layer by cleaning rods, etc.; by failure of the calcium carbonate to adhere to tubes already oxidized, corroded or dirty.

It becomes clear from this experimental work that dezincification, followed by pitting, is a phenomenon inherent in brass alloys of the type discussed.

The conditions for its appearance are the presence of certain kinds of water, of which natural sea-water was one, and of a certain temperature. Dezincification may be prevented, or at least postponed, by four different methods: (1) By using a suitable water-supply; (2) by using an alloy different from brass; (3) by adjustment of the temperature conditions when brass is used; (4) by electro-chemical protection.

In the mercantile marine (1) can never be employed, and it can rarely be used even in land installation. Moreover, there is as yet no precise information as to the kinds of water which will not give rise to dezincification. As regards (2), little information is at present available. An obvious suggestion is to lower the amount of zinc present in the alloy, and thus to diminish the tendency toward dezincification. As to how far, if at all, the elimination of zinc could be usefully carried, the authors cannot make any definite statement. It is, however, certain that a complete removal of zinc would give rise to serious trouble of another kind. Possibly there may be some alloy intermediate between 70:30 brass and pure copper which would be more resistant to corrosion than either, though whether it could be satisfactorily drawn into tubes is another matter. Probably manufacturers have already experimented privately along these lines, and information on the subject would be welcomed.

A number of alloys which contain no zinc suggest themselves as suitable for the manufacture of condenser-tubes. Phosphor-bronze has been proposed on a number of occasions. It can be drawn into tubes of good quality, and at first sight would appear to be an excellent material for the purpose. Under certain conditions, however, it appears to be subject to a peculiar and deeply penetrating form of complete corrosion, the cause of which has not yet been ascertained by the authors, and the phenomenon of "detinning" has also been observed. More work upon this alloy is desirable before it can be recommended for use. A copper-nickel alloy produced on a large scale in America, and known as "monel metal," has been used for condenser tubes. It appears to give satisfactory results as far as resistance to corrosion is concerned, but its high price has prevented its extended use. [This seems to contradict the Edison Illuminating Companies' results, previously mentioned.—Editor]. The work of Carpenter and Edwards would suggest the use of a copper aluminum alloy if it could be easily and cheaply drawn into tubes, but the authors have never had an opportunity of experimenting with tubes of such material.

As regards the immediate future, and pending future investigations on different types of alloy, the best means at the disposal of engineers for hindering corrosion appear to be: (1) The entire abandonment of the use of plain 70:30 brass and its replacement by either the Admiralty alloy, 70:29:1 (tin), or Muntz's special brass, 70:28:2 (lead); (2) careful control of the temperature in condensers; (3) the extended use of electro-chemical protection. The authors consider that the importance of temperature in determining the nature of

the corrosive attack on brass by sea-water has not received from engineers the attention it deserves.

The temperature of the water in a condenser can be kept down in the following ways: (1) By limiting the amount of steam condensed; (2) by shortening the path of the water through the condenser; (3) by increasing the speed of the water; (4) by preventing choking of the tubes, either by fitting screens or filters, or by frequent cleaning. The amount of steam condensed has been considered hitherto from the point of view of engine efficiency and space economy, and not at all from the corrosion standpoint. Nevertheless, it is a fact that, within the practical limits of temperature, the greater the amount of steam condensed the greater will be the tendency to selective corrosion, and if the condenser be really overloaded this form of corrosion may go on at an extremely rapid rate.

The practice of dividing a condenser into two "nests" is a distinct aid to corrosion. As the water passes through the lower nest it becomes heated, and consequently the top nest is supplied with water that is already warm and will become still more highly heated. From the corrosion point of view it would be preferable to introduce a separate water inlet and outlet to each nest of the condenser, and to discontinue the practice of building them in nests. The speeds of water through the condensers in the mercantile marine vary between 240 ft. and 360 ft. per minute. The average is about 290 ft. per min. The speed of the water used in the experimental plant was about 275 ft. per min. The faster the speed of the water in the condenser the lower the temperature, other things being equal, and the less the liability to the choking of tubes. In the authors' opinion the speed should be kept up at least to the highest figure mentioned above, and it might be worth while to try still higher speeds if the tubes frequently choke.

Inquiries made by the authors have shown that choked tubes are sometimes severely corroded, and sometimes not at all. If a choked tube be found in the bottom part of the condenser working normally it will not usually be corroded, since its temperature, even in this case, is still low; if, however, the condenser is being overloaded, as shown by the high temperature of the outlet water, it may be severely corroded. If a choked tube be found in the top part, however, it will usually show severe dezincification, owing to the high temperature to which it has been heated. Hitherto the corrosion of choked tubes has been attributed to the electro-chemical action of particles, more particularly of carbon, but this view has now been clearly shown to be untenable.

(Note—In the above abstract many of the statements appear merely categorical, which are in reality not so. Space considerations have dictated the omission of many of the committees' arguments. Those who wish to read the report in full are referred to the transactions of the Institute of Metals, or to "The Engineer," Sept. 5, 1913, p. 263; Sept. 12, 1913, p. 287 Oct. 4, 1913, and "Engineering," Aug. 30, 1913, p. 302, and Sept. 5, 1913, p. 339.)

Brazilian Power Station

Work continues on the port of Pernambuco improvements started about three years ago by the Société de Construction du Port de Pernambuco, says a consular report.

The jetties are being extended, the river dredged, and about one-half mile of the quays completed. A large suction dredge is rapidly filling in the space between the outer wall of the quays and the shore. This entire work, which will cost about $16,000,000, is expected to be completed within two years.

A concession for a new electric tramway and lighting system in Pernambuco was granted about 18 months ago to Dodsworth & Co., of Rio de Janeiro. This Brazilian company has made arrangements with J. G. White & Co., of New York and London, an English and American firm, to do the construction work. The foundation for the power house is being built and surveys made for the car barns and track, a portion of which has already been laid. The power machinery and rails are all of American manufacture. The power plant, when completed, will generate 4000 hp. The work is expected to be finished within one year.

Allen Friction Wrench

The accompanying illustrations, Figs. 1 and 2, show the Allen friction wrench in detail. The wrench consists of three working parts, so designed that it instantly

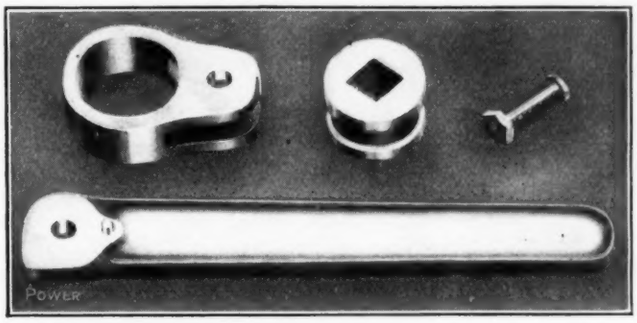


FIG. 1

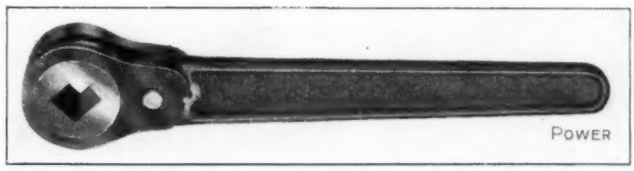


FIG. 2

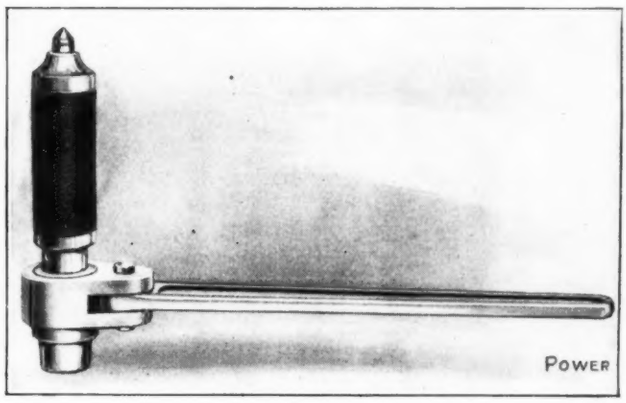


FIG. 3

grips the socket head, and turns it by friction alone. It is reversible, and can be used for left-hand work as well as for right. Fig. 3 shows the wrench applied for drilling purposes. It is manufactured by the Allen Wrench & Tool Co., 754 Eddy St., Providence, R. I.

A Two-Cent Rate—For the purpose of increasing the day load of the municipally owned Jacksonville, Fla., electric-light plant, the electrical committee of the board of bond trustees has authorized a straight cooking and heating rate of two cents per kw. hour. This means for Jacksonville what is supposed to be very close to the lowest rate charged for electric current for this purpose of any city in the country and it will attract widespread attention. That the Knoxville plant is owned by the city will probably be used everywhere as a convincing argument in favor of municipally owned electric plants. The new rate will prove a real factor in reducing the present high cost of living. Recognized experts state that this low rate will supply the necessary fuel for cooking at an average of less than 40 cents per person per month. Indirectly, by increasing the day load of the plant, it will help materially in adding to the city's net profits which last year exceeded $350,000. For a long time ways and means for increasing this day load have been seriously considered.

ELECTRICAL DEPARTMENT

Don'ts for Electricians

By H. M. Nichols

Don't use open fuses.
—— handle moving belts.
—— use rotten belts.
—— neglect storage batteries.
—— overfuse circuits.
—— allow belts to slip.
—— throw water on burning oil.
—— use acid salts in soldering.
—— leave joints without soldering.
—— put too much tension on brushes.
—— put water on hot bearings.
—— use emery cloth on brushes or commutators.
—— fail to replace cracked insulators.
—— step over, under, or through, moving belts.
—— strip the threads on foundation bolts.
—— use pliers with uninsulated handles.
—— burn the insulation on wires, when soldering joints.
—— burn contacts on knife switches, by opening them slowly.
—— hang clothing or other material on wiring.
—— use high-potential leads that are not properly insulated.
—— leave tools lying near a motor or generator.
—— expose electrical machinery or apparatus to moisture.
—— use lubricating oil in transformers.
—— use oil, in transformers, which has been exposed to moisture.
—— put a motor or generator on a shaky foundation.
—— run a booster without a speed-limiting device.
—— install an outdoor circuit without a lightning arrester.
—— do wiring without consulting the underwriters' rules.
—— try to save wire by freak layout of circuits.
—— leave loose or dirty contacts on switchboards.
—— forget the value of sand in fighting electrical fires.
—— meddle with circuits you are not familiar with.
—— run motors and generators without inspecting the bearings occasionally.
—— put up wiring without the proper fuses or circuit-breakers.
—— attempt to adjust series arc lamps with the current on.
—— start a motor without making sure that the field circuit is all right.
—— run a motor with a weak field.
—— make adjustments on motors and generators when they are running, this applies particularly to brushes.
—— bring a motor up to full speed too quickly when starting.
—— send a new man on a job which he does not thoroughly understand; it is dangerous for all concerned.
—— cut the blades on knife switches by adjusting the contacts too tightly.
—— block up the space in front of switchboards so that the switches cannot be reached immediately.
—— do high-potential testing, without first erecting red danger signs.
—— get your face over commutators, as there is always danger of a flash over.
—— handle meters roughly.
—— expose your watch to heavy currents, if you expect it to keep good time.
—— fail to read regularly at least one good engineering paper.
—— run a motor or generator until the windings get hot enough to smoke.
—— operate transformers without having the secondary windings grounded.
—— discharge storage batteries too low, and don't let them stand when discharged.
—— install conduit without grounding it.
—— leave packing boxes and other inflammable materials in the power house.
—— burn the contact buttons on starting boxes.
—— use brushes that are not properly fitted.
—— use both hands when working on live apparatus.
—— leave joints without taping.
—— fail to have a wiring diagram attached to each switchboard.
—— run a belt with the tight side on top.
—— run a motor or generator with a loose pulley.
—— use pulleys or couplings having exposed setscrews or bolts.
—— neglect to fence in all exposed belts and shafting.
—— allow dirt and oil to collect on the windings of motors and generators.
—— use the back of switchboards as clothes racks.
—— fail to treat every wire as though it were alive, until you have determined otherwise.
—— stop a motor without seeing that the rheostat arm falls back to the starting position.
—— lean against machines or switchboards.
—— open a main feeder switch, under full load, except in the case of an emergency.
—— fail to renew the oil occasionally in the bearings of motors and generators.
—— use a rigid coupling where a flexible one can be used.
—— connect alternating-current generators in parallel without first being sure they are in synchronism.
—— run a motor or generator with loose polepieces.
—— fail to ground lightning arresters.
—— spill oil on the floor.
—— store gasoline for blow torches in the power station.
—— handle the blow torch carelessly around inflammable materials.
—— neglect to remove temporary wiring.
—— use copper wire to replace blown fuses.

—— use plugs, for series arc switchboards having defective handles or frayed leads.

—— forget that 500 volts, or less, is sometimes fatal.

—— run a motor or generator which is vibrating badly.

—— couple two machines together without making sure that the alignment is perfect.

—— start a new motor for the first time without making sure that the armature turns freely.

—— install rheostats and other sources of heat without separating them from inflammable materials.

—— use wooden switchboards.

—— drive nails where there is danger of their coming in contact with concealed wiring.

—— put telephone or other signal wires above power wires.

—— cut open a cable and leave it exposed to moisture.

—— stop a motor by releasing the starting rheostat arm, without having first opened the main switch.

—— cut the strands in skinning the insulation from lamp cord.

—— throw a switch unless you know positively to what circuit it is connected.

—— leave oily waste in any place except metal waste cans.

—— fail to use the proper size starting rheostats for motors.

—— allow a single-phase induction motor to run on the starting winding.

—— neglect to run down grounds, and remedy them as soon as they show up on the ground detector.

—— start a series motor without first making sure that it is properly loaded, to hold down the speed.

—— forget that there is danger of injury from short-circuits on low-tension wiring, when tools are handled carelessly around bare contacts.

—— fail to consult the nameplates on motors and generators and make sure of having the proper voltage, before putting them in service.

—— start a motor by throwing in the main switch, without first seeing that the starting rheostat arm is in the off position.

—— connect different makes of transformers in parallel without first making sure that the polarity is the same in both.

—— open the field switch on a generator with the resistance all cut out of the control rheostat.

—— forget that there is always a possibility of low-voltage wires becoming dangerous, by accidental contact with high-voltage wires.

Overhauling a Railway Storage Battery

By Ben Dawson

In an electric-railway power plant with which the writer is connected, there is a storage battery consisting of 272 cells; each cell contains 15 plates, eight negative and seven positives. The cells are arranged in four double rows of 34 each, which brings all the cross-over connections at one end of the battery. The cells are connected by a permanent pure lead busbar, which necessitates burning all the plate lugs to the busbar. The battery is the Planté type.

Recently it became necessary to clean 136 cells, also to install new positive plates in all the cells that were cleaned. Since the battery is used to help out on the railway load and for lighting the power house and car barn after the cars are all in for the night, the writer had to adopt the sectional method of overhauling the battery, so as to least interfere with normal service conditions.

Sections of 12, 11 and 10 cells were worked on according to the position and finishing of each double row of cells. A ⅜-in. hole was drilled in the busbars that comprised the terminals of each section, and to these were fastened a dipped, soldered, copper angle busbar to which were connected the discharging cables, section-jumper cable and initial charging cables. One section was completely overhauled before commencing on another; the section first being discharged through a grid resistance switch and series-type ammeter, as shown in Fig. 1.

When the discharging current had reached a low point, the discharging cables were taken from the section ter-

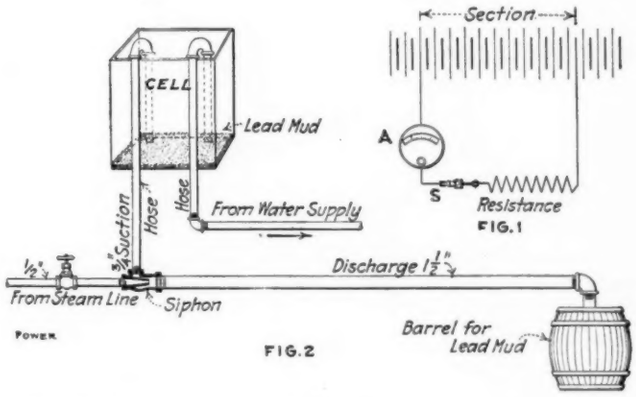


Fig. 1. Discharging Section

Fig. 2. Steam-Siphon Method of Cleaning Cells

minals. The section-jumper cable was connected to the section terminals, and all the positive-plate lugs in one cell in the section were severed near the busbar with a lug cutter. This opened the section circuit as well as the whole battery. All the positive plates in the section were then cut from the busbars, taken out of the cells and placed in a plate wagon and hauled out of the battery room. The old separators were also taken out of the cells and discarded.

Some of the old acid was saved and used in the hydrogen-gas generator, to make gas for burning the new positive plates. The negative plates were scraped with a thin, flat, wooden stick to remove all surplus loose, spongy lead. The positive sides of the lead busbars were filed with a roughing file to aid in lead burning the new plates to them. All the cells were cleaned by means of a steam siphon and fresh water supplied from a tank on top of the power house. The steam-siphon method of cleaning out the lead mud of the cells is shown in Fig. 2. In this case approximately 130 lb. steam pressure was used.

The purpose of the barrel was to collect all the lead mud, and holes were drilled near the top to allow the water to drain away and the greater part of the lead mud settled to the bottom of the barrel. There was a plentiful supply of fresh water and a pressure sufficient to stir up the lead mud in the cells. The hose that connected with the siphon was ¾-in. rubber steam hose,

and of sufficient length to reach the bottom of all the cells in the section. The water hose was also of rubber to withstand the action of the acid. After all the lead mud and old acid had been cleaned out, the negative plates were left covered with fresh water over night and siphoned out the next morning.

The new positive plates were brushed off with a clean, soft brush to remove surplus loose lead peroxide and dust previous to their insertion in the cells. After the positive plates had been properly spaced, oiled mild steel sub-burning bars were placed under the lead busbars and over cross-cell wooden supporting blocks in preparation for lead burning the positive-plate lugs. A special self-closing burning tong sub-burning bar, and plate lug were used for burning in the plates with hydrogen gas from a standard-type gas generator, and air pressure supplied from a pump and tank. After all the positive plates of the section had been burned, enough all-wood separators were made up to finish a section; these were thoroughly washed with fresh water, and allowed to drain before being inserted between the plates in the cells.

During the process of putting in the separators, care was taken to keep all dowels in line, starting with the first separator between the first and second plates nearest the body, and using a good strong wood stick to properly space and straighten the plates as the separators were being put in the cells. When all the separators of the section were in place, the section-cable jumper was taken off and new chemically pure sulphuric acid of 1.220 specific gravity was put in the cells sufficient to cover all the plates about one-half inch. The battery terminals were disconnected and the initial charging cables connected to the section terminals, and the overhauled section put on its initial charge.

A moderately high rate of charging was employed in this case, owing to the limited time and conditions, but the initial charge was not stopped until the specific gravity of all the cells in the section had maintained the same readings for several hours, and the plates were in a safe condition to be put into active service. At this juncture the charging cables were taken off, and the battery terminals connected so that the whole battery was ready for night service. The rest of the sections were treated similarly.

CORRESPONDENCE

High Voltage

Mr. Stockwell's letter in the Nov. 11 issue relative to trouble with the voltage of an alternator is not specific enough. He mentions that the plant has three alternating-current generators and that two of these machines show a voltage of 2300 volts while the third registers 2350 volts. He does not state, however, whether or not the machines were operating in parallel when this condition existed.

If they are in parallel on the same busbars, slowing down, or attempting to do so, on one machine only reduces the load taken by that one machine and transfers it to the other two. This increase of load on the two machines and decrease on the third, tends to slow down the heavily loaded machines, and speed up the lightly loaded machine. This action will tend to bring the machines into equilibrium and all three machines will run at the same speed, regardless of the setting of the individual governors.

Mr. Stockwell mentions that there is a Terrill regulator on the system. If the machine with the higher voltage is on the busbars to which the regulator is connected, changing the speed or the field current, within certain limits will not affect the voltage, as the Terrill regulator tends to keep the voltage constant at a certain value, for which the regulator is adjusted.

With the machines in parallel the adjustment of the rheostat after it is once set, should not be tampered with, as this affects only the power factor of the individual machine, causing it to take a heavy, lagging, wattless current. Adjustment of the governor of the machine affects the load as carried by this machine.

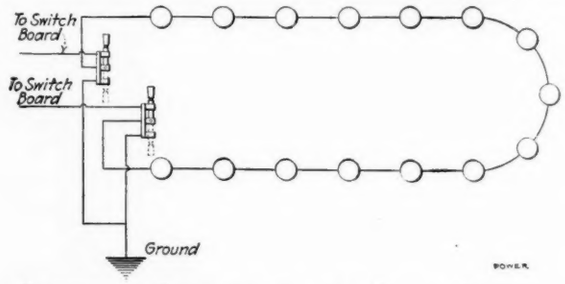
I think that Mr. Stockwell will find that either the voltmeter-transformer ratio of the one machine is different from the ratio of the transformers on the other two machines, or that his voltmeters need recalibration. There is also a chance that the resistance of the leads connecting the transformers of the 2300-volt machines to the voltmeter may be great enough to make this difference. Two or three volts drop in these leads would be sufficient to make a 50-volt difference on the voltmeter scale.

JAMES M. PURCELL.

Richmond, Va.

Protecting the Lineman

The sketch shown herewith is of an arrangement of switches put in the plant to protect the lineman while trimming the arc lamps. Each side of each circuit that leads out of the power house has a single-pole, double-



GROUNDING SWITCHES ON ARC-LIGHT CIRCUIT

throw switch in it. The top lug is connected to the wire that leads from the arc-lamp switchboard; the wire that leads out of the building to the arc-lamp circuit is connected to the middle lug and the wire that leads to the ground is connected to the bottom lug.

When the lamps are in service the switches are thrown up, but when the lineman goes out to work on the line, the switches are thrown down as indicated by the dotted lines; this grounds both sides of the arc-lamp circuit.

This arrangement protects the lineman from any shock either static or high tension. Should the arc-circuit line be crossed with another line the current will pass to the ground through the ground switch and the man trimming the arc lamp will not be injured.

We use two switches on each circuit, so that if the arc-lamp circuit should be open at any place each side would be protected by the ground.

Yazoo City, Miss. A. G. VINSON.

GAS POWER DEPARTMENT

New Process of Cleaning Producer Gas

A decidedly novel method of cleaning producer gas is described in a paper by H. F. Smith, of Lexington, Ohio, which was presented at the annual meeting of the American Society of Mechanical Engineers.

Referring to the illustration, the raw producer gas on leaving the producer is first cooled to a point where the tar vapors are condensed by being passed through a primary cooler or condenser. From this the gas is carried into an ordinary rotary gas pump *B* which delivers the gas under pressure into the main *C;* it is then delivered through a porous diaphragm *E* and discharged from there into the main *F*. A sump or separator *G* is provided in which the tar accumulates.

The structure of the diaphragm *E* is of considerable importance, for the successful carrying out of this process and the materials used seem to have an important bearing on the operation of the equipment. The diaphragm must be sufficiently porous to permit the gas and tar to pass freely; otherwise it will soon become blocked with deposits from the gas and fail to operate. Many materials may be used for this purpose, but at present spun glass is preferred. The density of the diaphragm can be regulated by the quantity of glass used and by the degree of compression maintained between the metal screens. Ordinarily, the thickness of this diaphragm is about ¼ in. The diameter must be adjusted in accordance with the quantity of gas to be treated. Ordinarily about 400 cu.ft. per hr. can be handled for each square inch of diaphragm area.

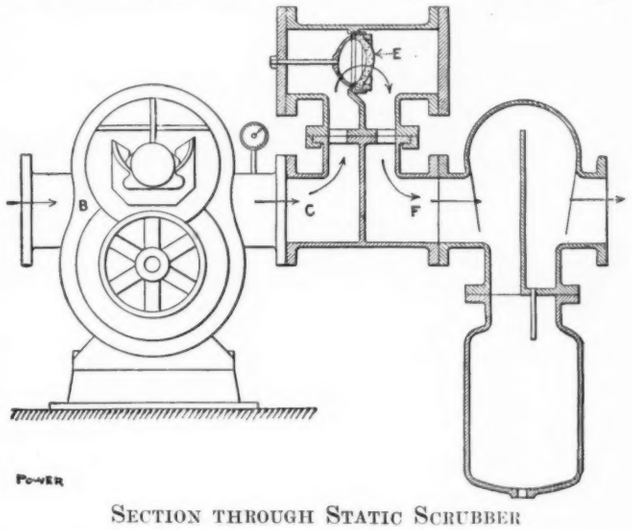
In passing the diaphragm an important change in the physical state of the tar occurs. On the entering side the tar exists in a large number of minute particles, ordinarily known as tar fog. In passing the diaphragm these particles are caused to coalesce so that on the discharge side the tar particles are relatively large, so large in fact that they can no longer be carried forward in the gas current and immediately separate out by gravity. All that is necessary for the complete separation of the tar from the gas is to provide a sump, or drip, into which the precipitated tar can drain.

It appears to be possible to secure almost any desired degree of gas cleanness simply by regulating the pressure maintained across the diaphragm. In ordinary commercial operation, it is found that a difference in pressure of from 2½ to 4 lb. will give a degree of cleanness that is ample for any commercial requirement.

At low velocities the gas will pass through the porous diaphragm without any apparent alteration, and the effectiveness of cleaning is directly related to the velocity of flow. For example, the degree of cleanness produced with the velocity of flow resulting from 5 lb. pressure is very much greater than that produced by the velocity of flow resulting from 1 lb. pressure, and when the velocities are as low as those produced by a pressure of a few ounces only, there is no perceptible change in the tar content of the gas after passing through the diaphragm.

No water is used in connection with this process except that required to cool the gas; consequently there is no production of tar emulsion and the water flowing from the condenser is perfectly clear. The tar separated by this process is practically water free, and can be used for any purpose to which coal tar is adaptable.

For the maintenance of continuous operation the tar must be sufficiently fluid to pass through the porous diaphragm without creating undue resistance, and therefore it is necessary to maintain the temperature of the gas



SECTION THROUGH STATIC SCRUBBER

entering the diaphragm at a point that will reduce the viscosity of the tar to as low a point as is consistent with complete condensation of the tar vapors.

This apparatus would not be well suited for use on gas containing large quantities of lampblack or for the purification of gas from coals yielding very heavy viscous tars. For high-volatile coals, however, such as are found in Ohio, Indiana and Illinois, and for lignite, it has been found in practice to be thoroughly practical and effective.

The exact method by which this tar extractor operates has not been conclusively demonstrated. The first and most obvious theory is that the tar particles are precipitated by being brought into direct collision with the threads or filament of the porous diaphragm. That this does not constitute a complete explanation of the process is indicated by the fact that the material of which the porous diaphragm is constructed has a marked bearing on the effectiveness of the process and would indicate some action other than simple mechanical collision. For example, if the porous diaphragm is made up of steel-wool instead of glass-wool (the physical structure of the diaphragm being as nearly as possible the same in each case) the process does not operate with anything like the effectiveness secured with glass-wool diaphragms. It would seem that the possibility for collision would be the same in both cases.

It is possible that in addition to the effects of mechanical collision there may be an electrical attraction exerted by the glass fibers constituting the porous diaphragm which are located at microscopic distances from each other and which are undoubtedly subjected to some electrification from friction with the gas currents. If the possibility of such electrical action is considered, the increased effectiveness of glass as compared with steel for the construction of the porous diaphragm is satisfactorily explained. That friction of this nature is capable of producing electrical disturbances of considerable magnitude is well established.

The first commercial equipment of this kind has now been in continuous operation for approximately 18 months. This outfit is handling gas for a producer-gas power plant of approximately 1000 hp. The second commercial equipment is handling approximately 900 hp. producer gas, and has been in daily service for approximately 10 months. The largest single installation is an equipment for cleaning 200,000 cu.ft. of gas per hour.

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Suction-Producer Operation

By George W. Muench

In the July 15 issue there appeared an article by the writer on lignite producer troubles, commenting on the various suction-producer troubles and their remedies. The present article gives a general outline of lignite suction-producer operation with a view to the prevention of the commoner troubles.

The producer being ready for operation, the first procedure is to start the fire. Place upon the grate a small quantity of oil-soaked waste; any old waste which is ordinarily thrown away will do for this purpose. Then on top of this waste should be placed dry shavings, small pieces of wood, or any other dry waste material that collects around a plant. This should extend to a height of about 2 ft. above the grate. If the wood contains considerable pitch, not so much need be put into the producer.

Before lighting the fire be sure that the vaporizer contains water, also that all the water seals are filled. In case the gas enters the scrubbers before escaping through the purge, the water must also be turned on the scrubbers. The purge being opened, ignite the fuel on the grate. The ash and fire-doors should now be closed; also the pipe supplying moist air from the vaporizer should be closed. The blower is now started. In some installations the centrifugal scrubber acts as a blower, drawing air through the regular air intake, and to hasten the fire it is often helpful to open the poke holes near the level of the grate.

When the wood is burning freely fill in about a foot or a foot and a half of coal. As soon as this burns freely the producer may be entirely filled with coal. The blowing should be continued for some time. If the installation has a test cock between the producer and the purge pipe the gas can be tested frequently and as soon as it burns with a blue flame without sputtering it can be led to the engine. The purge at the engine should then be opened and that at the producer closed, the gas being allowed to escape for a few minutes, so that ample time is allowed for all the apparatus between the engine and the producer to be filled with gas. There should also always be a test cock at the engine. As soon as the gas proves satisfactory here it is ready for use in the engine.

If the plant operates continuously, that is, 24 hr. per day, it is more difficult to prevent weak gas, clinkering, engine slow downs, etc., because the producer fire has to be worked with the load on the engine. When operating only part of a day, 8 or 10 hr., it may be necessary only to work the producer before starting in the morning, or better still a good working after shutting down at night, or probably both. If it should be necessary to work the fire in the mean time it might be done at the noon hour when the load is ordinarily less. To get the most efficient service the operator must perform the various operations carefully and so far as possible at equal intervals of time, and in the same regular rotation. It is hardly possible to give an operator definite directions as to what method is best suited for his plant; his experience must teach him this. Neither is it possible to tell him how much time he may safely allow for these various operations without danger of letting the gas become too weak. However, the work should always be done as rapidly as possible, as an excess of air will always affect the steady running of the engine.

One question the operator will ask himself many times is: "How can I prevent the formation of clinkers?" First of all, to prevent clinkering and to keep soft those clinkers that have formed, plenty of steam must be admitted, yet not too much, for it will cause the formation of too much hydrogen which in turn causes preignition in the engine, one of the most serious engine troubles. When operating with a clinkering coal the fire must be worked oftener, but not so hard each time. Keep the fuel moving, so as not to give the clinkers much chance to fuse to the fire-brick lining. Yet one must not work the fire too often as that will cause a waste of fuel and usually a weak gas. The removal of clinkers must not be neglected, for if they gather on the walls in large quantities it will mean hard work to get them out without drawing the fire, to say nothing of engine shutdowns. When poking from the top to loosen clinkers the new operator should always be careful not to jam holes in the fire-brick lining instead of in the clinkers. Holes in the lining are excellent places for the formation of clinkers. Having loosened the clinkers from above, work them down to the grate and remove them from below by working through the poke holes at the grate. It has been the writer's experience that the less the fire is poked from the top the better. When the producer is operating properly there is really no reason why it should be poked from the top and if rocking grates are installed there need be no poking from below except when troubled with clinkers. Do not disturb the fire any more than necessary, and the result will be economical operation.

Ashes can be removed from the ashpit whenever the operator finds time. Remove the ashes as rapidly as possible, to prevent much air from entering through the ash door. Of course, when the ashpit consists of a water seal the removal of ashes is made easier, because no air can enter providing the seal is kept filled while raking out the ashes.

Directions for producer cleaning sometimes recommend first filling the producer with fresh fuel. In the writer's opinion this is not best, for clinkers, if present, are harder to work through the bed after charging. Also if holes have been formed, the fresh fuel, especially if pea size, will find its way into the lower zones and into the ash and will be removed from the grate before being

thoroughly burned. By working the fire first and getting it into good condition and then adding the fresh fuel it need not be disturbed again. Of course, enough fresh fuel should always be present to supply the necessary amount of gas. In case the fuel bed is exceptionally low it may be well to add some fresh coal before working the fire and then finish charging the fire after having worked the producer.

The lignite producer trouble most feared is tar. With present-day washing apparatus, however, there need be little tar trouble. If the installation is what it should be it is up to the operator to get clean gas at the engine. With a down-draft producer the gas washers need not be of the same degree of efficiency as with the updraft, as much of the volatile matter gases in the hot zone of the fuel bed.

About two gallons of water per horsepower per hour is the least that should be used for thoroughly cleaning the gas. The speed of rotary washers is of great importance, the higher the better, and it should be at least 1000 r.p.m. The writer recalls a plant where tar was causing trouble. By increasing the speed of the centrifugal washer from 900 to 1250 r.p.m., the trouble was remedied. Centrifugal washers are equipped with screens, and broken screens often cause inefficient operation of the washer.

When a plant is operated only during the daytime and shut down every night some operations necessary for putting the plant in condition for the night are of importance. The engine is stopped by closing the gas valve and opening the switch in the ignition circuit. Immediately the purge at the engine should be opened to provide an escape for the gas, as the gas continues to be formed in the producer for a short time after the engine has been shut down. Next open the purge at the producer and shut off the air and steam; shut off the water supply to the scrubbers. Experience will soon tell the operator how much opening of the air valve on the producer is necessary for sufficient draft to keep the fire alive over night, yet not cause waste of fuel. Having worked the fire, removed the ashes and charged the producer, the plant is ready for the night. The engine requires no attention other than shutting off the cooling water and oil. It is also well to put the engine in starting position, so all will be ready in the morning.

To start the next morning remove the ashes from the grate; if necessary work the fire and charge the producer. Having started the blower turn the water on the scrubbers. Blow up the fire for a few minutes and purge at the engine until ready for use.

It becomes necessary occasionally to clean the scrubbers and pipe lines. The doors on the scrubbers should be opened to allow the gas to escape; this may take an hour or more; then the coke or laths, whichever is used, may be removed. When replacing the coke after having cleaned the scrubber, care should be taken not to break it. The coke in the bottom of the scrubber should be from 3 to 4 in. in size, and at the top not smaller than 1½ to 2 in.

Many plants are now using centrifugal washers. Steam can be used to good advantage for cleaning a centrifugal washer, and the screens in this type must be kept clean to insure its efficient operation.

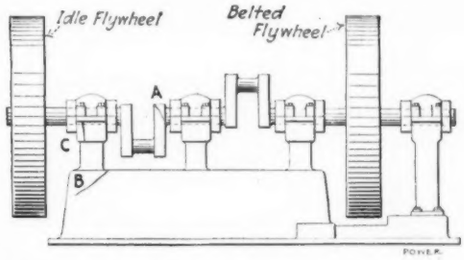
If properly installed the pipes can be readily cleaned without removing any sections. All bends should have tees or crosses with blank flanges. By removing these blank flanges the pipes can be cleaned very readily. Also steam, if it is to be had, comes in very handy for thinning the tar in pipes, and with a slight dip toward the producer much of the tar will run out and thus save considerable labor.

It is always well to attend to all cleaning in the daytime, so that it will not be necessary to use a light, as more or less gas may be in the apparatus and cause an explosion. It is also advisable to have more than one person present while cleaning is being done. The operator should always bear in mind that the gas is very poisonous and if breathed in any quantity will cause violent headaches, and sometimes unconsciousness or even death.

Broken Crankshaft

The accompanying sketch shows how the crankshaft of a two-cylinder gas engine was broken in a small electric-light plant near here. This is a mixed plant consisting of a 100-hp. steam turbine direct-connected to a 75-kw. generator and an 85-hp. gas engine belted to a 50-kw. generator.

The gas engine was running on very light load, in fact, almost idle, as it was Sunday morning. The engineer had just stepped out into the boiler room when he



CRANKSHAFT, SHOWING LOCATION OF FRACTURES

heard a heavy pounding in the engine room, and rushing in saw the idle flywheel on the gas engine wabbling. He displayed presence of mind in shutting down the engine as he had to pass directly in the path of the flywheel in doing so, and a few more revolutions would undoubtedly have caused it to part company with the engine with disastrous results.

An investigation showed the shaft to be broken off as indicated at *A*; the bedplate was cracked in two places, at *B* and *C*. Both cracks and the break in the shaft were new.

The cause of the accident is not known, although it is possible that the bearings were out of line, caused by bearing No. 1 getting hot at some previous time and some of the babbitt being wiped out.

M. W. UTZ.

Minster, Ohio.

Displaces Steam—It is stated on good authority that a 70-foot all-steel gasoline electric car, costing approximately $40,000, has been put in operation between Jackson and Columbia, Mississippi, by the New Orleans & Great Northern R.R. and made its first trip recently, displacing the steam train that has heretofore run over that road. The car in question has a seating capacity of 85 people, and a 11-ft. compartment for baggage. The manufacturers guarantee that it will make 60 miles an hour hauling two trailers. It is said that this is the first gasoline electric car ever put into service by a Mississippi railroad.

REFRIGERATION DEPARTMENT

Setting Expansion Valves

By Thomas G. Thurston

Setting the expansion valves on a large system with a number of valves is the most important part of the refrigerating engineer's daily routine. This is especially true in a direct-expansion system.

In setting the expansion valves two factors are to be considered; the expansion coils and the machine working on them. To secure maximum efficiency from the expansion coils the whole length of the coils should be used for evaporation. Whatever portion of the coils is used for superheating the vapor after it has been evaporated is of little use as far as refrigerating effect is concerned. This can be readily seen when one remembers that it takes, at 15 lb. suction pressure, approximately 572 heat units to evaporate 1 lb. of liquid, while one heat unit will raise the temperature of 1 lb. of vapor approximately 2 deg. As the temperature difference between the evaporating ammonia and the outside of the coil is seldom over 15 or 20 deg., it will only take from 8 to 10 heat units to bring the temperature of the vapor up to the outside temperature. Also, while the temperature range, and consequently the rate of heat transmission is gradually decreasing while the gas is being superheated, it remains constant and maximum while the liquid is being evaporated.

It is of prime importance then to have the whole length of the coil in contact with ammonia liquid or wet vapor. If more liquid is fed to the coil than can be evaporated it makes no particular difference as far as the coil is concerned, it would simply escape from the end of the coil into the suction line. This, however, would more than likely cause disaster at the machine. Taking the machine and coils both in consideration the maximum capacity is obtained if the vapor leaves the coils in a saturated state with no entrained liquid. In this case the coils will work at maximum efficiency, there will be little heat taken up while the vapor is passing through the suction line from the coils to the compressor, and the vapor will arrive at the machine in a condition favorable for most efficient operation. If the vapor should be superheated before leaving the coils, it will superheat more in the suction line. The vapor will expand and less ammonia will be handled per stroke of the compressor, thus cutting down its capacity. On the other hand, if liquid ammonia is carried with the suction vapor from the coils, it will evaporate either in the suction line or in the machine, without doing useful work in the refrigerator, and the efficiency of the plant is cut down.

The problem is then to set the expansion valves so that the coils will get all the liquid they will evaporate and no more. This is not so hard to determine where a cooler with a single-expansion valve is used and thermometers are placed in the suction line to the compressor. The expansion valve is adjusted until the suction vapor is 1 or 2 deg. higher in temperature than the saturated vapor at the suction pressure at which the machine is operated.

When the valves and coils are multiplied the trouble begins. How is the operator going to determine when each coil is getting just what it will evaporate and no more? This is a hard problem and is never mastered until the operator is thoroughly familiar with the peculiarities of each individual expansion valve. An expansion valve is seldom opened more than from a quarter to half a turn of the wheel. Now a quarter of a turn on a valve with quite a little lost motion will probably only crack it off the seat. If the valve has no loose connections it will open it quite a little. Again, the condition of the valve and seat may make a difference.

In most of the older plants the engineer judges the working of the system by the frost on the machine. Taking this point alone into consideration may be misleading as a thermometer in the suction line when there are a number of expansion valves. It is possible to get the proper temperature of vapor or the right frost at the machine with only a few out of a number of coils working properly. To illustrate I can remember one case where we were running three machines together on four different brine tanks. As the frost began to come off the machines I went over and opened up the expansion valves on the two nearest tanks which seemed to be a little short of ammonia. When I came back to the engine room I was surprised to find the frost leaving the machines at a still greater rate than before. I looked at the thermometer in the suction line of one of the machines and found the temperature had risen about 10 deg. I hurried back to the tanks and opened the valves a little more without results. The next time I opened the valves quite a little more and I found the temperature of the gas coming down, but I still had to open up a little more to get them just right.

Another case was that of a small machine running on a direct-expansion system in a number of freezers. The first day I operated this machine it nearly drove me wild. I kept trotting between the freezers and the engine room nearly all day. The machine started to get a little too cold to begin with so I went up to the freezers and shut off the expansion valves a little. When I came back to the engine room the head pressure was nearly up to where the relief valves would blow and the machine was just as cold as ever. In my anxiety to get the head pressure down I hurried back to the freezers and opened a few of the expansion valves quite a little. When I came back to the engine room I found the head pressure down and the machine warming up. It was not long before the machine was running too warm, so back I went to the freezers and opened the valves a little more. This made matters worse, so I had to repeat the performance. This happened several times during the day.

The trouble in both cases was the same. Some of the valves had been opened too much and some not enough. In the first case I had opened the valves too much on two of the tanks and not enough on the other. The net

result was satisfactory as far as suction-gas temperature and the frost on the machine was concerned, the extra amount fed through the valves on two of the tanks cooling the superheated gas from the other two tanks to the proper temperature.

In the second case, with the direct-expansion machine, the valves were open very little and foreign matter would clog them. When the valves clogged the liquid naturally crowed through, the valves remaining open, and one or two of these most likely had been opened too wide in the first place. The result was that the machine froze up. When I shut off the valves still more it simply aggravated matters, because this cut down the flow through all the valves remaining clear, running up the head pressure and forcing a still larger proportion through the valve that was open widest. On the next trial I happened to open the valves that were clogged. This reduced the head pressure, cut down the feed on the coils causing the trouble and the superheated gas from the coils on which I had just opened the valves neutralized whatever excess was fed through the other coils.

In both of these cases I had overlooked two important points, the suction pressure and the appearance of the suction valves on each individual coil. In either case the suction pressure would have been below normal and the suction valves on the coils getting too much liquid would be frosting heavily while those that were not getting enough would show little frost or most likely be thawing off.

The suction pressure in connection with the temperature of the suction gas or frost on the machine is one of the best indications of the working of the system, but gives no basis on which to judge of the working of the individual coils. This can be determined only by observation, study and experiment. The sound made by the liquid passing through the expansion valve, the appearance of the frost on the expansion and suction valves, the appearance of the coils themselves in direct-expansion work, with the temperature variation as indicated by the thermometers, where the coils are working in separate rooms, are all good indications of the working of the coils. If an expansion valve sounds "dead" or gives no sound and the corresponding suction valve is thawing off, it will be known that the feed is stopped on the coil. If the expansion valve sounds all right, but the suction valve is thawing off while all the others are frosted it indicates too light a feed on the one valve. If in a freezer it is found that the temperature has gone up or has remained stationary when no additional stock has been stored, the coil is not getting as much ammonia as it should and the expansion valve should be opened wider. The action of a coil can be judged approximately by the way a moistened finger sticks to it. If the whole length of the coil is evaporating liquid ammonia the finger will stick all the way along to the suction valve. If only a small part of the coil is evaporating liquid there will be quite a little difference between the way the finger sticks at the part in which the liquid evaporates and where only vapor is in contact with the coil. Along the vapor section most likely the finger will not stick at all, this depending on the temperature of the room.

On the other hand, if the machine starts to freeze up and it is found that one room has dropped several degrees while the others have remained normal, and it is evident that the coil is evaporating liquid all the way to the suction valve, this coil is without doubt the cause of the trouble, and the feed should be checked accordingly. Sometimes, however, it is necessary to experiment with several expansion valves before locating the trouble.

Care should be taken not to open the expansion valves too wide. This can be done when the system is short of ammonia. In such a case vapor blows through with the liquid. This is indicated by the frost disappearing from the expansion valves, and if the valves are opened still more the expansion valves, liquid header and sometimes the liquid line for quite a distance will all become frosted. The obvious remedy is to charge more ammonia into the system, but if this cannot be done at the time, the expansion valves should be closed enough to remove the frost on the high-pressure side of the valves.

One point to remember is, that the valves at the end of the liquid header farthest from the supply will feed faster than those nearer to it, especially if the header is long, the supply at one end and the ammonia feeding through fast. This is due to the velocity of the moving volume of liquid and also to the fact that the valves nearest the supply will get most of the vapor carried with the liquid. Consequently, these valves must generally be opened more to feed the same amount of liquid as those farther back.

For the best economy carry the highest suction pressure possible, with the proper temperature of the suction vapor. To determine this, experiment with the expansion valves, noticing the effect on the suction-gas temperature of each individual valve. When the proper point is found for the existing conditions, the suction-pressure gage and the suction-gas thermometer or the frost on the machine will indicate any defective working of the coils.

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Pipe-Line Refrigeration

With the recent advancement that has been made along refrigerating lines it appears that the subject of pipe-line refrigeration has not received the attention that it deserves. Though in use for a number of years in some of the large cities in the United States, such installations are more or less foreign to the average refrigerating engineer. Nearly every city or hamlet in the country has its ice plant and a desirable location for a new installation is difficult to find. There is, however, an unlimited field for pipe lines and if pushed in the future like ice plants in the present and past, there would be a vast amount of work for all builders of refrigerating machinery. On the above subject, G. F. Bein read an interesting paper before the Third International Congress of Refrigeration. His experience and, therefore, his remarks were limited to the direct-expansion system.

One of the principal annoyances appears to be the excessive use of ammonia. No matter how carefully the line was watched the ammonia would get away. In the five years that Mr. Bein served as master mechanic and superintendent of the system an average of about 20,000 lb. of ammonia per year was used. During this time, there had been several accidents. Twice there was a rupture in the line and once the baffles in the cooling tower let go and crashed through the roof and on top of the ammonia condensers. As nearly as could be estimated at the time the loss of the ammonia in each case amounted to about $4000. Under regular operating con-

ditions probably from 16,000 to 17,000 lb. of ammonia were used per year. This is probably not excessive, considering the length of the mains, as there were between three and four miles of trunk lines and a mile or more of laterals.

Large losses are apt to occur as the mains are all underground in a conduit and a leak is hard to locate. There is more or less water in the conduit in low places which acts as a natural absorber of ammonia and even after the leak is stopped the weak solution of aqua gives up a strong odor.

The greatest trouble usually exists in the manholes, where the valves and expansion joints are located. Any material change in pressure or temperature due to a shutdown or heavy frosting out will usually start a number of leaks. The danger of fire, particularly if it occurs at night, is always a source of trouble. Every customer has a stop box at the curb, where it is possible to shut off the ammonia, but at times the fire has a good start before it is discovered and a falling wall may rupture a line and, perhaps, waste the greatest part of the charge.

A condition seldom met with in any other refrigerating system is the highly superheated condition of the return vapor. This is governed by the climatic conditions. In hot weather the return vapor will rise to 75 and 80 deg., owing to the temperature of the ground. From mercury wells placed in the lines regular readings were taken and it was found that when the return gas was most highly superheated, the best work was being done on the line.

The theory advanced for the heavy ammonia losses was the decomposition of the high-temperature gas, but if such is the case it would be interesting to know what becomes of the foreign gas, for seldom, if ever, was there any purging. In the opinion of Mr. Bein the line losses amounted to about 50 per cent., but, on the other hand, there was a decided gain on the outgoing liquor, as it usually left the plant at from 90 to 95 deg., but was delivered at the expansion valves at 75 to 80 deg., or about ground temperature.

Another annoyance is the meddlesome customer, who usually thinks that if a little is good, more is better, and frequently helps himself to a few full turns of the expansion valve. This was obviated by taking the handling of the valves out of the customers' hands and protecting the wheels with lock shields.

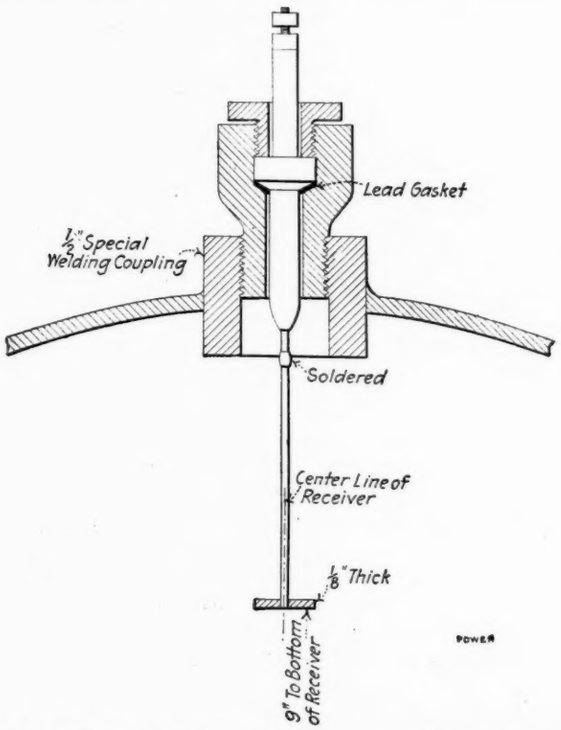
Several creameries were operated on the brine system, and the good satisfaction these systems gave led to a consideration of a pipe-line system operated with brine. Then, at least, there would be some chance to detect the leaks and stop the losses. The brine system, however, also has its objectionable features, as there is a loss both coming and going, while on the direct-expansion system, as already stated, there is a material gain on the liquor leaving the plant. It also requires cumbersome auxiliaries in the form of circulating pumps; but this is more than offset by the fact that all of the ammonia is under immediate control at the power plant, and that the storage of outsiders' goods, as well as the opening of doors or burning of lights is recorded on 24-hr. charts.

One of the great advantages of the brine system would be the ease with which connections could be made into the mains for new or prospective customers. In the first place the entire system should be in the form of a loop, then by closing the valves at the street intersections, the connections could be made with scarcely any loss of brine, while in the direct system it often requires a half day to pump out, and then if the valves are leaky or the system is more or less foul with oil, it cannot be fully accomplished and connections are often made under partial pressure. The result can be readily imagined.

The question of fixing rates and insulation together with the above troubles are the principal objectionable features connected with pipe-line refrigeration, and if they can in a measure be overcome, there is no reason why nearly every city of any size cannot add refrigeration to its other utilities.

Electric-Pump Control for Liquid Receiver

In a certain cold-storage plant there is an ammonia separator in the main suction line, so that no liquid can get into the compressor. The liquid from this separator is drained into a receiver made of 15-in. pipe 6 ft. long.



SPARK PLUG AS INSULATED ELECTRIC CONTACT FOR LIQUID RECEIVER

An electrically operated pump was desired so that when the liquid in the receiver reached a certain level the pump would operate and pump the liquid into the main receiver where the pressure was 185 lb. as against 15 lb. in the receiver placed in the suction line. The conditions required a contact wire that would be insulated from the receiver and extend down into the receiver so that when the liquid had risen to a certain point the liquid, contact wire, and the iron receiver itself would make a closed circuit. As a means to this end I utilized the ordinary automobile spark plug shown in the sketch as being the simplest, cheapest and most satisfactory method. This arrangement operated through a solenoid switch which cut in the pump motor.

ROBERT S. WHEATON.

Milwaukee, Wis.

EDITORIALS

Conservation of Water Powers

Gifford Pinchot and his followers in the conservation movement demand that there shall be no perpetual grants of power sites, and that the government shall, by regulation of rates and charges, share in the profits of all power plants built on navigable streams or in the public domain. Opponents of this policy assert that such restriction and regulation will drive capital away from investment in water-power enterprises. The "Pinchotites" regard the tendency toward private monopoly of water power as a serious menace, which if uncontrolled is likely to make the whole country under tribute to a water-power trust. The opponents scoff at the menace of monopoly, and say that development of water power to save coal and other fuel, is of higher importance than the matter of regulating rates or preventing monopoly.

The Pinchot faction points to the growth of water-power development under the Forest Service's strict regulation, as proof of their contention that their policy does not discourage capital from investment, and they seem to have the best of the facts, the financial reports generally indicating that water-power enterprises are paying larger returns to investors than railroads, utilities and industrial undertakings. There is also pertinency in the suggestion that the holding by ten large large groups of water-power interests of three and half million horsepower undeveloped, while they have developed less than half that amount, indicates that the difficulty is not in restriction of grants, but in nondevelopment of powers already granted.

It is inevitable that sooner or later Congress must give more careful attention to the water-power question than it has yet received, and must decide upon a definite policy, not subject to the whims of cabinet officers or the discretion of public officials.

It is not at all likely that the nation will agree to turn over these national resources and properties to state control and disposition. The history of the wasteful and careless handling of natural resources when they have become the football of state politics, is not such as to encourage giving them more plunder from the national resources. It is not likely, either, that there will be a return to the granting of perpetual grants or franchises for water powers.

If the criticisms of the antis prove valid, and capital will not seek investment under limited franchises and regulation of rates and capitalization, that problem will be solved when we come to it. Possibly it may be found wise for the government to develop its water powers in the public interest, as the nation has reclaimed millions of acres of the arid lands of the West without profit.

There is as yet, however, nothing to indicate that capital is fighting shy of water-power enterprises, even under strict regulation. In fact, as with railroad regulation, there is a growing sentiment among cautious investors in favor of enterprises where Uncle Sam guarantees careful supervision of the manner in which the money is spent and the business is conducted, even if it does not promise as large returns as did the old system of unrestricted exploitation.

Closely following the split in the National Conservation Congress, the House of Representatives is asked to investigate the charge that under a perpetual franchise and state regulation, the building of the great Mississippi River power plant at Keokuk has done nothing to benefit the consumers or the public. It is charged that the rates made by the company are as high as the cost of steam power, and in some instances higher, and that the contract made with the city of St. Louis alone, taking but a small part of the output of the plant, will yield sufficient return to pay five per cent. on the company's total investment.

Record Keeping

One of the important duties of an editor of this paper is to visit power plants for the purpose of obtaining first-hand information on actual operating conditions. These visits reveal, among many other things, a lack of record keeping of plant performances that is astonishing in view of all that has been said and shown to emphasize the importance of the practice. And this paucity of recorded information is not confined to small plants. It exists in plants where the opposite conditions would be expected.

Then, too, plants are found where the multiplicity of record and report forms would bewilder a confirmed systematizer. Often this condition is temporary, for it proves difficult in practice to arrive at the most suitable forms without having come to them by the adoption and elimination of numerous others. The condition is then excusable.

In some plants where the management insists on a division of costs for power as delivered to the various departments, for convenience the total cost is apportioned equally among the departments. Sometimes this may be permissible, but often it is ludicrous, as, for instance, in a department store, where the shoe department is charged with as much refrigeration as the kitchen or fur department. If costs are to be divided among departments at all, it would be worth while to investigate so that the charge may be accurate and equitable. If then it should be desired to ascertain the cost of power or the power consumption per unit of product from a particular department it will not be necessary to guess. Where an attempt at completeness in cost keeping is made, accuracy should be paramount, and usually it is not easy to be accurate.

Some engineers who have installed complete cost-keeping systems in their plants obtain estimates from the local power companies as to what they would furnish light and power for, and then put the difference—when the lower cost is in favor of the plant—in a sinking fund to offset the depreciation charge. This is truly good engineering.

A well kept system of record and cost keeping will do more than anything else toward whipping an old plant into shape or keeping a new plant in proper condition, if the engineer and manager are eager to apply the knowledge gained by the revelations of the system.

It is indeed to be regretted that in so many plants record and cost keeping are so grossly neglected when they are so badly needed. It is to their reproach that this can be truly said of power-plant engineers.

The Locomobile Principle

The most efficient use of steam in a heat engine is exemplified by the locomobile, which, on believable tests, has produced a horsepower-hour on less than eight pounds of steam, and the Ferranti turbine, for which a performance of seven pounds of steam per brake horsepower-hour, is reported.

The feature common to both of these is superheat of high degree, and repeated application. In the locomobile the steam is highly superheated as it goes to the high-pressure cylinder, is reheated by passing through another superheater on its way to the low-pressure cylinder, and both cylinders are bathed continuously in flue gases hotter than the steam which they contain. In the Ferranti turbine the steam, initially superheated to some seven hundred degrees Fahrenheit, surrounds the high-pressure barrel tending to keep up the superheat during expansion, and as it passes from the high- to the low-pressure section, the steam is reheated to the original temperature, and surrounds the low-pressure barrel at that same high temperature, so that the working steam which would otherwise be cooled by expansion below the point of saturation, actually goes to the condenser, or to the feed-water heater which precedes it, in a superheated condition.

The reheating feature, while it could be effected by high-temperature steam brought from a distance, suggests the proximity of the boiler and the motor which it supplies, and we are quite likely to see the locomobile principle used upon a larger scale. The capacity of the unit need not be restricted to that of an engine or turbine which a boiler will carry upon its back, nor to that of a shell boiler. There is no reason why a good-sized engine or turbine should not be placed in the locomobile relation to its boiler or boilers, which may be of the water-tube type hung to the same structure which carries the prime mover.

"Editions" and "Impressions"

Do you know the difference between "editions" and "impressions" in book-buying parlance?

As the difference has been much misunderstood by many readers of technical and engineering books, and as the publishers themselves have discussed the use and misuse of these terms in their trade press, we take this opportunity of making clear that difference. Let us assume that you bought an engineering book five years ago and that the title page bore this line: "Third Edition—1908." Then, recently, you discover a later "edition" bearing the line: "Fifth Edition—1913," and you conclude that your old book is out of date.

You buy the new book, and on its comparison with the 1908 edition you find that, beyond a few plate corrections and a change of date on the title page, there is no difference between them. Then you say things!

What you really bought was a new "impression"—a reprint of an exhausted third edition. While the publisher may not have intended to practice a willful deception, his book is really sailing under false colors, and you are ready to believe that the publisher has preyed upon your credibility, to say the least.

While the idea is so new to many, for several years it has been our practice, or that of the McGraw-Hill Book Co., to retain the date on the title page of a book from its first publication until it was thoroughly revised, and calling the reprints "impressions," not editions, as "First Edition, Second Impression."

Altering the date, it is claimed by some publishers, prevents the purchaser from "fearing that the book is too old," and thus lessens its sale. Changing the title-page date will not make an old edition new any more than would a new nameplate make over an old engine.

An experienced book buyer will invariably look at the copyright date before purchasing and verify the publisher's claim that he, the buyer, is getting a new "edition," not a new "impression."

It is to be hoped that a standard practice will soon be fixed by all reputable publishers, thereby insuring the purchaser that their books bear no evidence of fraudulency and that their title pages prove a true bill. In the meantime, watch the copyright date if you are seeking a new edition rather than a new impression.

What is the committee of the American Society of Mechanical Engineers appointed to urge the establishment of an industrial museum going to do about it?

According to Secretary Daniels, the navy has used during the past year thirty million gallons of fuel oil. At present, however, only a small proportion of the warships in service, the later battleships and destroyers, are equipped to burn oil, but practically all the vessels now building will be thus equipped. When it is recalled that the government is paying over twice as much for oil as it did in 1911, the probable extent of Uncle Sam's oil bill in the near future is apparent. Secretary Daniels urges, as a step toward economy, that the government refine its own oil from its petroleum in the Elk Hills and Buena Vista fields of California and thus be independent of market prices.

Another attempt is to be made to reorganize the Portsmouth Coal Co., which is itself a company reorganized from the old Rhode Island Coal Co. Hayden, Stone & Co. now hold the property as security for an unpaid mortgage of $80,000. The present proposal is to form a new company with a capitalization of 1,000,000 shares of the par value of $1 each, and to ask the present shareholders to buy the new stock at par.

There are extensive deposits in Rhode Island and southern Massachusetts of a hard graphitic coal. Many attempts have been made to mine it commercially, but never with permanent success. The coal will burn all right under proper conditions, and has a fuel value which ought to warrant its mining. We hope that the next attempt will be allowed to rest upon its own basis of facts, and that no attempt will be made to boost it up with such a nostrum as Williams' catalytic treatment which was an unfortunate feature of the last attempt.

READERS WITH SOMETHING TO SAY

Experience with Boiler Graphite

I have been reading with interest the articles that have appeared in POWER from time to time relative to the use of graphite as a scale preventive and remover. In the plant where I am employed the use of graphite was prohibited, as it was tried in one of the company's other plants and the results were far from satisfactory as the graphite carried over and clogged the cylinder drains, etc. This, I believe, was due to a poor grade of graphite, excessive foaming and overload.

About a year ago our boilers became so badly scaled that it was necessary to retube them. After this was done I received permission to paint the shell with graphite. On Dec. 11 and 16 I graphited and cut in boilers Nos. 4 and 5. The graphite in No. 4 was rubbed on dry and the results obtained were not as satisfactory as in No. 5, as the graphite used in this boiler was mixed with water to make a fine paste and applied with a brush, afterward being rubbed to a glossy finish. The boilers were cut out Jan. 7, being in active service 22 and 27 days respectively, being 2 and 7 days overtime as our service-time limit on boilers was 20 days. After the boilers were cooled down and washed out we were astonished to find only a fine gray powder on the sheets. This powder could be brushed off with a cloth and the graphite was still on the sheet. This was surprising as in the past it took four days to chip the scale from the bottom sheets.

I consider one should be very careful in the use of graphite in old and badly scaled boilers, and blow them down frequently and do not try to run too long before finding out what action the graphite has on the scale as the scale falling from the tubes forms a solid mass on the sheet and if the boiler is not blown down in time to remove this, a badly bagged sheet will be the result. Some time ago an engineer told me of the use of graphite mixed with white shellac. I would like to hear from some reader of POWER who has tried it.

C. R. VAN KEUREN.

Famosa, Calif.

Your Son's Vocation

The question of a son's vocation, brought up in the editorial in the Oct. 28 issue, is all important. The first requirement is a good education. By the time the son has finished high school he will be old enough to and should decide what he wishes to make his life work. It is the father's duty to acquaint the son with his trade, enough for the boy to determine whether he wishes to follow it or not, be it engineering, carpentering, doctoring or what not. Many successful engineers came from the farm with no other machinery to cultivate their bent for engineering than a passing locomotive or a thrashing machine. As far back as I can trace on both sides of the house there was only one engineer, and he was a backwoods sawmill man. From him I got my first inspiration, and I find very little interest in other than mechanical things. I am an engineer because I like the work and for no other reason.

When my two sons have an education, I shall advise them to look about and see what trade or vocation they prefer, and when that is done I shall urge them to get the proper training to make a success of it no matter what the trade is so long as it is honorable. The man that is not well versed in his vocation will not be a success, and in seeing others advance above him will think he has chosen unwisely, and his sons will receive little or no encouragement to follow his lead.

Many young men are prone to choose a clerical or office line of work because it is clean and looks easy when in reality they would be better off physically, mentally and financially in an engine room or foundry or some other place where the work was neither easy nor clean, and will worry along through life just around the corner from the poor house.

Regardless of what the son does choose as a life work he should be encouraged to make himself as proficient as possible in that line.

J. C. HAWKINS.

Hyattsville, Md.

Horsepower and the Power of the Horse

I have read with interest your editorial on page 574 of the Oct. 21 issue on "The Origin of the Term Horsepower as Applied to Mechanical Work." I think that for the benefit of the younger engineers who may read this article a little additional explanation may be of interest.

While it is true that reliable experiments have shown that the continuous work of a horse is more accurately shown to be 22,000 instead of 33,000 foot-pounds, the fact remains that in most cases the load is carried in one direction only; the return trip being made light, and in many cases the distance hauled is comparatively short. This being the case, authorities as quoted by Haswell show that the work of a horse will be from four to five or six times the normal rate.

To illustrate: A few years ago the company of which the writer was chief engineer received an order for a small haulage machine. The specifications were taken from our catalog and called for the smallest size listed. The request for information regarding the work to be done by this machine failed to bring the desired information; in fact, their statement in substance was that they knew what they wanted and if we did not care to furnish it, doubtless someone else would. The order was accordingly filled and a few months later we received a letter stating that there was something wrong with our machine. They wrote that they had purchased a 12-hp. machine, but it would not do the same work that had been previously done by three mules. Further corre-

spondence brought out the fact that these mules were hauling coal cars up a short grade and returning cars empty; in addition, of course, the engine had increased the hauling speed and the output, so that the work they desired required a 25-hp. engine.

This illustrates very forcibly the trouble encountered by many inexperienced engineers who attempt to install mechanical in place of animal power, and I feel that the point deserves emphasis.

J. H. Stratton.

Cleveland, Ohio.

Condensate Accumulator for Turbine

Mr. Purcell's idea of using a 60-gal. tank to catch the condensate in the exhaust of a turbine as told in the Oct. 28 issue, p. 611, is simple and at the first glance would appear feasible, but I do not consider it an advisable method, although it may be cheaper than any other in first cost. In allowing the tank to fill to the exhaust pipe before draining, there is danger of water-hammer in the exhaust pipe in two ways. One is, that at the proper time for draining the tank the attention of the attendant might be called to something more serious for the time being, or it might possibly be forgotten, which would allow the water to back up into the exhaust pipe and cause water-hammer. The other reason is that the height of the water cannot be seen until it reaches the danger point, and should the tank be nearly full, and the turbine pull over a slug of water the tank would be no protection to the exhaust pipe. If, when draining the tank, the inlet valve was not closed before the atmospheric valve was opened, some water might be drawn into the exhaust pipe by the vacuum therein and the same conditions would be present as before. Another reason is that the arrangement takes much time for proper attention and must be very closely watched to prevent filling up as the amount of condensate is not always the same. The tank would be better if provided with a water-gage about half way on the tank and a small pump or a good trap to the 1½-in. drain pipe. This condensate is pure water without any oil or scale-forming matter, and should be returned to the feed-water heater. The arrangement he shows will do the work provided it is watched close enough and might do so for months without trouble, and yet, in five minutes it could do damage enough to pay for the cost of a reliable pump or trap.

H. C. Jones.

Baltimore, Md.

Testing Fire Hose

The responsibility of testing fire hose usually devolves on the engineer in charge of an institution or building, and as the matter is becoming more important, it is believed the following hint will be of value to those on whom this duty rests.

The usual way in which fire hose is tested is by means of water and as if there were a fire. While this method has certain features which may recommend it, it has several inherent defects which make it impractical in many cases, and further opens the way to an early decay of the hose, especially as the hose is seldom dry when returned to its rack. Should the hose burst during the test, damage is sure to result which will sometimes greatly exceed that of the value of an entirely new hose. Again, a test of the hose should be made at least once a year.

The better way is to test the hose with air at, say, 100 lb. pressure. This can be done readily in many plants having air compressors. In case there is not a compressor in the plant one may be often easily procured, and if that is impractical then the next best thing is to take the hose to a place where there is a suitable compressor. The hose will leak appreciably but not abnormally. Should there be any weak spots in the hose they can be readily detected.

An advantage of air is that the hose can be handled without danger of soiling the clothes of the tester, and in case of bursting practically no damage will be done, and immediately after the test the hose can be replaced on the rack. The test can be made in almost any part of the building, and in general is as handy and desirable as could be desired.

A. P. Connor.

Washington, D. C.

Lubricating Inclosed Engines

Mr. Burmfirth, in the Sept. 16 issue, gives a description of the manner in which he cleans the oil in his inclosed-type engines. We accomplish this in a different but satisfactory manner. The engines are 250-hp., high-speed inclosed type. Each is equipped with a gravity-oiling system having a cast-iron tank of about 4 gal. capacity on the engine frame over the guides. This tank is piped to the top of the crank, main bearing, and crosshead with a feed valve in each line.

After passing over the bearings the oil is drained into the crank case and then to a cast-iron tank placed under the valve-gear, and below the level of the crank case. This receiver holds about 3 gal., and is divided into two compartments. One side is filled with water up to within ½ in. of a hole in the partition which is located about 3 in. from the top. There is a fine-mesh strainer in the top of this side through which the oil passes. This prevents particles of waste and sand from going over with the oil. The oil from the crank case runs through this strainer into the water where particles of metal, sand, dirt, etc., that are too fine to be stopped by the strainer are washed out in passing into the water, and the clean oil overflows into the other side of the tank. There is an oil pump placed in this side and operated by the valve-gear.

This pump forces the oil back through a ¼-in. pipe to the tank on top of the frame, the oil being used over again. This system holds 5 to 6 gal. of oil and 1 gal. of water in the dirty-oil receiver. We use a good grade of engine oil, and the old oil is all taken out, and new oil put in once a month. The old oil is run through a filter with a steam coil in the bottom of it, and used for valve-gears, pumps, shafting and in the crank case of the stoker and fan engines. Each of the high-speed engines uses from 5 to 6 gal. of oil per month. This is a good system of oiling except that the oil is kept too warm, and, although the oil is fed in a stream to the bearings, they run very warm. The lubrication at the end of the month seems to be as good as at the beginning when the new oil is put in, and there is very little difference in the temperature of the bearings with old or new oil. The bearings are tightened up about once in two months. The

time required to clean this oiling system is about ½ hr. per engine per month. In this system, a good grade of oil is essential. At one time a cheap grade was tried, but did not work satisfactorily, also the filtered oil was used over again, but that caused trouble from warm bearings, and it was found best to use a good grade of new oil on the engines and use the filtered oil for other purposes.

H. J. Cooper.

Annapolis, Md.

Boiler Attachments

The series of articles* on the installation and care of boiler attachments, by J. E. Terman, especially No. 3 on water columns, feed valves, etc., cannot be too highly commended. Some of his statements are open to argument, for there are some questions that never will be settled satisfactory to all engineers.

It has been my lot to fall in with some of the dangerous conditions he mentions as bad practice. In one case, all the feed valves were 2-in. globe valves, placed to close against the boiler pressure, so that they could be packed when closed, if the pump was stopped, with steam on the boiler, and no pressure on the stem packing.

On several occasions the disk of the valve between the check valve and the boiler came off the stem, and we had to pull the fires and cut out the boiler to prevent its burning; then it required some time to locate the cause of the trouble. The valves were turned around at the first opportunity.

Another trouble was with the internal feed pipes, where the water was bad and scale formed, stopping them up so badly that sometimes the pipe threads in the bushing in the head were stripped. Changing from iron to brass pipe of a larger size helped the trouble.

In another plant the water-alarm whistle blew, as the fireman supposed, for high water. After blowing down awhile, and seeing that the whistle did not stop he decided that it was low water. The glass was high up and the water level could not be easily seen. Fortunately, no damage was done. If there had been no high-water alarm there could not have been a mistake.

In one case the cylinder-head packing of a feed pump would not hold. A gage was put on the discharge pipe and when the feed regulator closed the pump pressure went up to two and one-half times the boiler pressure. The trouble was caused by a bypass around the pump governor being partly open, and was not noticed for some time.

In regard to fusible plugs, I have in mind a plant of 4000 hp. of water-tube boilers, nine boilers, and not a fusible plug in any of them. Another plant of six boilers is without plugs; another, a government plant of four boilers, is without fusible plugs, also a number of others, all in a state having a rigid boiler law.

J. C. Hawkins.

Hyattsville, Md.

Pipe Work and Fittings

It seems as if everything pertaining to engineering matters in general has been discussed in technical magazines, with the exception of pipe-fittings and pipe work, and when we come to think a little on the subject, we realize that there is room for better knowledge of fittings and general pipe work.

Send a helper for a fitting and he will probably return with something entirely useless for the work. I have had engineers come to my plant for odd fittings, when doing repair work, who could not name the proper fittings wanted. "Lemme see whatcher got" was their way out of it. Supply men find it difficult to take orders for fittings from some engineers, many having to sketch odd ones to show just what is wanted. In large plants where large assortments are kept in stock, the man in charge must certainly know his fittings to enable him to make requisition for those to be replaced.

Reduced tees, ells, couplings, etc., should be properly figured so as to have as few joints as possible in a pipe line, although but little attention is sometimes paid to neat workmanship, so long as the gas or liquid to be conveyed reaches its ultimate destination, less several per cent. of its original velocity.

Many engineers have bushed fittings to save a few minutes time, only to regret it later. When the pipe man comes for an odd fitting, do not tell him to "bush it," but take time to get what is correct. Bushings are not ornamental in pipe lines, especially in engine or boiler rooms where they are subject to the gaze of those who notice such things.

In a small plant I happened to visit some time ago, the engineer had just completed a soap-boiling arrangement which required four bushings to bring it down to the proper sizes. The odd part of it was that he had placed the order for the fittings for the job. "Took some figgerin'," he said, "to make um come out right." Such jobs look untidy and also cost more.

Go over a pipe line and observe the unnecessary joints. Don't tear the line out to remedy the trouble, but in future use only the joints that are absolutely required. An idea of properly built pipe lines can be had by examining some automatic sprinkler installation in your neighborhood, which, if well designed, will have no extra joints and the lines will be properly fastened or suspneded as the case may be.

A catalog from any reputable fitting manufacturer gives the proper names for all classes of fittings, valves, hose connections, hangers, etc. One will be surprised how easily it is to get a good working knowledge of the parts, and probably order the pipe and fittings for a complete pipe line less the last length, which must be cut on the ground, owing to the difference in the amount of thread various fittings will take. Pipes threaded with new dies will enter a fitting much farther than those cut with old dies.

Second-hand fittings have caused engineers to "lose their religion" when steam was turned on a repaired line only to give an imitation of a Chinese orchestra, but these occurrences can be lessened by using a little judgment in selecting the fittings. All second-hand fittings should be closely examined when dismantling a line and again when ready to use a second time. Sound your fittings the same as tubes or flywheel, and save hours in time and lessen the leaks and danger of bursting fittings.

When a joint is unusually hard to break, what do we do? Hammer the fitting, use an oversized pipe wrench, and add a few feet of pipe to the handle for extra lever-

*See pages 461, Sept. 30; 560, Oct. 21; 618, Oct. 28; 635, Nov. 4, 1913.

age, and yank away. Easy for you, but rather hard on the fitting. Such fittings should be carefully examined before going back to the supply room. If the pipe threads enter the fittings too far, throw it away, unless you want to do the work over.

Unions cost money, it is true, but use them when passing through places difficult to repair. Do not build a line two or three hundred feet long without unions, as a leak may occur near the center. Never make up joints dry, but use some ready-made pipe compound, graphite and oil, white or red lead, and save yourself many a cuss word when making changes in a line you never expected to take down.

FRITZ W. FISCHER.

Knoxville, Tenn.

Running Cross-Compound Engine on Light Load

Among the engineers at a recent gathering was a road man employed as an erecting engineer by a well known firm of engine builders, who related an experience met with during the last winter. He told what had to be done (and the cost thereof) to the low-pressure side of a vertical cross-compound engine that was completely wrecked, due to ice forming in the hotwell of a sufficient thickness to effectually seal the tail pipe, causing the exhaust pipe and cylinder to be filled with water when the priming pump was started.

This led to a discussion of operating compound condensing engines. Some present said it was their daily practice to run with a vacuum in the receiver on starting up and on very light loads, and could see no objection to this practice. One man stated that in his opinion it was dangerous to carry a pressure in the receiver on light loads, because the low-pressure side would be doing all the work, and the high-pressure piston might pull water up from the receiver through the exhaust valves. Others were of the opinion that the above argument might apply if the pressure in the receiver was supplied direct, as through a bypass, but that it did not hold if the receiver pressure was due to the exhaust coming from the high-pressure cylinder, as in that case the water could not back up against the pressure. Another engineer stated that it was his practice to run during the noon hour with a greatly diminished load (only a little above friction) with all drips wide open, and a vacuum in the receiver, having followed this practice for over five years without any trouble whatever. He said that the receiver was fitted with a reheating coil, supplied with steam at boiler pressure from the main line, the object of which was the reëvaporation of a greater part of the condensation.

A correspondent has recently called the attention of engineers to two articles which have appeared in POWER on the subject of water in the engine cylinder: one June 25, 1912; the other Aug. 26, 1913.

In the former article it was shown how water may come through the high-pressure cylinder and accumulate in the receiver, and become a menace to the low-pressure side by its being likely to be taken over into the cylinder.

The latter article described a series of tests made by some engineers in Belgium, during which water was purposely pumped into the steam pipe supplying the engine. The conclusions reached by these gentlemen were: That every precaution should be taken to keep the receiver well drained, notwithstanding the report that "the engine suffered not the slightest damage during the tests."

I heartily agree that it should be kept well drained, but cannot see how the ordinary trap can drain a receiver when it has no pressure to make it work, or when the cutoff is so short on the high-pressure side that there is a vacuum in the receiver as a result. Even should there be no trap, but just an ordinary pipe open to the atmosphere, it could not drain, for the atmospheric pressure would exceed the receiver pressure and keep the water in. Receivers are likely to be subjected to boiler pressure at any time. Should it contain a reheating coil, a split in the coil or a burst fitting and boiler pressure in the receiver is the result.

Should an admission valve stick open from any cause, the same result will follow.

Receivers should be tested to 50 per cent. above the highest running pressure and that is more than they would ordinarily be subjected to under running conditions. Intending purchasers of this type of engine would do well to put a clause in their specifications to this effect and see to it that it is carried out by the builder. In view of the importance of this subject, may I venture to suggest that the editors of POWER invite readers to discuss the subject, stating what is their practice in starting and running under light-load conditions with compound condensing engines?

H. ROLLINS.

Plainfield, Conn.

[We should be pleased to publish such discussion.—EDITOR.]

Testing Tightness of Cover Joint

Recently I had occasion to grind to a snug fit a cover for a small tank made of 4-in. brass pipe. After grinding in the cover until it seemed the joint was air-tight as described, I was at a loss to test the joint because I could not drill a hole in the tank to attach a gage.

I decided to blow steam into the tank and quickly put on the cover, allowing the steam to condense, thereby forming a vacuum. This was done and as the vacuum was maintained for a considerable time, I decided the joint was tight enough.

W. C. DIXON.

Hastings-on-Hudson, N. Y.

Abandoning a Boiler in Case of Fire

Referring to Fred W. Hener's question in the Sept. 16 issue, my advice would be: Leave the pump and engine running to utilize the steam and keep the boiler supplied with water. The engine will slow down as the steam goes down. The pump will keep water supplied so there will be no danger of a boiler explosion.

The question was conditioned that the engineer had no time to draw fires. In that case he would have only time to run away and the best thing to do would be to let things run down and run for his life. If we all failed to answer as long as this the questioner could have been burned up long ago.

F. A. MATHEWS.

Clinton, Iowa.

ENGINEERS' STUDY COURSE

Trigonometry—III

Beginning with this lesson the answers to the previous lesson's study questions will be given first, before the new lesson is taken up, and, as a rule, the answers will be given more fully worked out than has been the practice heretofore. The idea of the new arrangement is that the student, starting with what is practically a review of the previous lesson, will find it easier to proceed with the extension of the subject.

Last Lesson's Answers

6. As given in the "Last Lesson's Answers," page 801, No. 1; the *sine* $A = 0.6$ which, according to the table, is between 0.5878 (sin 36 deg.) and 0.6018 (sin 37 deg.). Taking any of the other functions the angle will be found to be the same, somewhere between 36 and 37 deg., and much nearer the latter. For example, the cosecant is 1.6666, which is between 1.6616 (csc 37 deg.) and 1.7013 (csc 36 deg.). From more exact tables it could be found that the angle A is 36 deg. 52 min. 11.64 sec.

7. The hypothenuse of the right triangle involved is given as 100 ft., and the altitude as 60. The relation $sin\ A = \frac{a}{c}$ becomes $sin\ A = \frac{60}{100} = 0.6$ which as found in the last answer corresponds to an angle of practically 37 deg.

8. The sides involved are those concerned with the functions of tangent$\left(\frac{a}{b}\right)$ or cotangent$\left(\frac{b}{a}\right)$. If $a = 2b$, then $\tan A = \frac{a}{b} = \frac{2b}{b} = 2$. From the table the angle whose tangent is 2 is about 63½ deg.

9. If the side c equals 1, the other sides of the right triangle correspond directly to the sine and cosine of 30 deg., or, from the table, 0.5 and 0.866.

10. In Lesson I, the sine of an angle (forming part of a right triangle) was defined as the ratio of the opposite side to the hypothenuse, and the cosine as the ratio of the adjacent side to the hypothenuse. On these premises the sine of one of the acute angles of a right triangle is equal to the cosine of the other acute angle. This was also shown in Lesson II, and, in addition, that the sine of an angle is equal to the cosine of its complement. Then the two acute angles of a right triangle are complements, or together equal to 90 deg., and the third angle is by construction a right angle (90 deg.) so that the three angles total 180 deg. Another proof might be developed from Fig. 4, last lesson. Angles IAB and BAC were complements by construction. All that needs to be shown then to prove the proposition is that the angles IAB and ABC are equal. The sine being equal to the opposite side divided by the hypothenuse, $sin\ \angle\ IAB = \frac{DB}{AB}$ and $sin\ \angle\ ABC = \frac{AC}{AB}$, but since $AC = DB$ the sines and hence the angles are equal.

Logarithmic Functions of Angles

In many trigonometrical problems multiplication or division of functions of angles are involved. For those preferring to use logarithms for their other problems in multiplication and division, tables are constructed which give directly the logarithms of the natural numbers corresponding to the functions of angles, thus saving the necessity of looking an angle up twice or in two different tables. These logarithmic tables of trigonometrical functions are very convenient and are to be found in most handbooks and mathematical textbooks. Tables can be had carried out to degrees and fractions of degrees (minutes or even seconds). In these logarithmic tables, to avoid the numerous negative characteristics that would otherwise have to be used, the characteristic of each logarithm is increased by 10. In the natural table it can be seen how many of the numbers are less than 1. All of these would normally take logarithms having negative characteristics, but increasing them by 10 they are all made positive.

Relations between the Functions of an Angle

There are ten fundamental relations which the trigonometrical functions of any angle bear to one another. The student who would go very far with this branch of mathematics should memorize these relations until they are as familiar to him as the multiplication table.

The first of these propositions is that the square of the sine of an angle plus the square of the cosine is equal to 1. Expressed as an equation it is

$$sin^2\ A + cos^2\ A = 1 \qquad (1)$$

The diagrams, either Fig. 3 or Fig. 4, show this to be merely the old familiar proposition that the square of the hypothenuse of a right triangle is equal to the sum of the squares of the other two sides. In a right triangle where the other two sides are the sine and cosine the hypothenuse is equal to 1 and the square of 1 is 1.

The second proposition is expressed

$$Tan\ A = \frac{sin\ A}{cos\ A} \qquad (2)$$

From Lesson I and Fig. 2.

$$Sin\ A = \frac{a}{c}\quad cos\ A = \frac{b}{c}\quad tan\ A = \frac{a}{b}$$

Substituting these values

$$Tan\ A \text{ or } \frac{a}{b} = \frac{\frac{a}{c}}{\frac{b}{c}}$$

the second member of which reduces to $\frac{a}{b}$ by canceling the "c's," proving the proposition true.

In the same way the third to the sixth propositions, inclusive, may be proved as follows:

$$Cot\ A = \frac{cos\ A}{sin\ A} \qquad (3)$$

for the equivalent is

$$\frac{b}{a} = \frac{\frac{b}{c}}{\frac{a}{c}} = \frac{b}{a}$$

$$Cot\ A = \frac{1}{tan\ A} \qquad (4)$$

for $\frac{b}{a} = \frac{1}{\frac{a}{b}}$

$$Sec\ A = \frac{1}{cos\ A} \qquad (5)$$

for $\frac{c}{b} = \frac{1}{\frac{b}{c}}$

$$Csc\ A = \frac{1}{sin\ A} \qquad (6)$$

for $\frac{c}{a} = \frac{1}{\frac{a}{c}}$

The seventh and eighth propositions are similar to the first and would be proved by the right triangle $AEFA$, Fig. 3, Lesson I.

$$sec^2\ A = 1 + tan^2\ A \qquad (7)$$

$$\overline{AE}^2 = \overline{AF}^2 + \overline{EF}^2$$

for $AE = sec\ A$, $AF = 1$ and $EF = tan\ A$

$$csc^2\ A = 1 + cot^2\ A \qquad (8)$$

for $\overline{AG}^2 = \overline{AI}^2 + \overline{IG}^2$ and $AG = csc\ A$, $AI = 1$ and $IG = cot\ A$.

The ninth and tenth propositions were covered in Lesson I, namely:

$$vers\ A = 1 - cos\ A \qquad (9)$$

$$covers\ A = 1 - sin\ A \qquad (10)$$

As is evident from the fourth proposition, *the tangent and cotangent of the same angle are reciprocals of each other as are also the secant and cosine and the cosecant and sine* from propositions five and six.

Study Questions

11. Express the tangent of the angle A in terms of its cotangent. If the tangent is equal to 3, what is the cotangent?

12. Given $\tan A = \frac{4}{5}$, find the other trigonometrical functions without using the table.

13. Prove that the sine of 30 deg. equals ½.

14. Find the other trigonometrical functions of 30 deg.

15. What is the versine of 45 deg.? Find the other functions also.

❖

Erratum: On page 801, under "Last Lesson's Answers," a multiplication sign was used by mistake for a plus sign in answer No. 2. Corrected the equation would read $c = \sqrt{a^2 + b^2} = \sqrt{24^2 + 143^2} = 145$.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Hobble skirts and high heels were responsible for 52 accidents in October, complains the Pennsylvania R.R. Ain't them th' sore guys, Constance! Gawd knows, we has our troubles gettin' classy duds without them choochoo Johnnies a-buttin in— Hello! Yes? I gives you your number twicet, an'— What's that? You're no gen'elmun! As I wuz sayin', Constance— Sure, them engine pushers is bugs!

❖

San Francisco recently moved an 8000-ton, three-story school building across sand lots, over four streets and two car tracks, and set it down without hardly displacing a brick. It's far easier to move a brick school than it is to move the average school board—and you have a wild desire to displace a load of brick, and shy them.

❖

A young man getting $75 a month got tired of comparing this carfare with the millions he handled, and then he copped half a million and lit out for the bright lights. Served the trusting trust company right. Perhaps it will pay the next man living wages and help him to keep honest.

❖

To what parlous state has Springfield, Mo., arrived that it must have an armed guard to protect its sewers from vandalism? Run the vandals through the sewer a couple of times. This is a sure cure.

❖

Every funny man in every funny column of every funny publication (except, perhaps, the "Congressional Record") in these United States has made facetious remarks anent the cur who beat his wife 2080 times in 40 years. We're going to keep mum—principally because our remarks would not be allowed to go through by the postal authorities.

❖

"How far must an engineer be guided by his client's resources?" asks John M. Goodell in the "Engineering News." Why didn't you ask us, John? Right off the reel, we'd get a line on how big the client's resources were, and then we'd keep a-inchin' and a-inchin'.

❖

The linemen had completed the wiring in a Delphos, Ohio, home and had "proved out," when the boss lineman noticed that a blank socket had been plugged with a champagne cork.

"Whadcha plug the socket for?" he began. "The juice won't ——"

"Ja, dot's it!" exclaimed the Teutonic mistress of the home. "Ach, dere no light is, undt I put me a cork in to keep der juice from running oudt undt spoiling der carpet!"

❖

They say that earthquakes have been drilling holes in the bottom of the sea. Somebody page McGinty and let us have the facts.

❖

The Sanitary Sons of Harvard, an organization of sanitary engineers! Pleasedtomeetyer! There's a big call today for clean men, and these sons must be clean to come right out in the open with the label.

❖

An old and valued contributor, who is alert to his literary shortcomings, writes that he refuses to die the longest day he lives. As he's "the livest reader 'Power' has," he's just going to keep aplugging. He doesn't give a durn what we editors think. Come across, Mac, as often as you like!

❖

Uncle Sam, have you no bowels of compassion? The charwomen, scrub-ladies and other humble toilers in the Capitol got their June pay on Oct. 31. Oh, Sammy!

❖

There is no such thing as a criminal type, declares Doctor Goring, of His Majesty's prison at London. Ain't, hey? If the printer set it "infernal" instead of internal combustion, and "pullets" instead of pulleys— This is criminal type enough for us.

Refrigerating Engineers Meet in New York

On Dec. 1 and 2, the American Society of Refrigerating Engineers held its ninth annual meeting in the Engineering Societies Building, New York City. Three sessions were held on Monday and one on Tuesday, with an old fashioned beefsteak dinner at Healy's as a final to the convention. There were a number of good papers which were heard by a large attendance, and enthusiastic discussion on various points indicated the interest that had been taken in the society's work during the regime of Retiring President Neff. He had asked for coöperation, and as stated in his address had in a measure received it. Individually many of the members were doing yeoman service. More organized effort, however, was wanted. There was need of good team work, and unless the society awakes to its opportunities it may have to follow instead of lead. Reference was made to the work of the International Association of Refrigeration and the influence of the Congress recently held in Chicago. There were many problems in the field ripe for attention, and it was the president's urgent desire, that the society should attain in their solution the standing that it should have.

The balance of the morning session was devoted to routine business, an expression from the floor favorable to holding the next Western meeting in San Francisco in 1915, and the announcement of the following officers for the year to come: President, Henry Torrance, Jr.; vice-president, Theodore O. Vilter; treasurer, George A. Horne; directors, V. R. H. Greene, J. S. De Hart, Jr., A. P. Criswell, E. F. Miller and F. E. Matthews.

Monday afternoon the session opened with an interesting paper on "The Sterilization of Water by Ultra-violet Rays" by Max von Recklinghausen, of Strassburg, Germany. Although not relating directly to refrigeration except in the sterilization of water for ice making, the paper was well received and brought forth many pertinent questions from the audience. It developed that the cost of treatment amounts to about 30 watt-hours per ton (about 240 gal.) of water, and that the average life of the lamps used for the purpose approximated 3000 hr.

John C. Sparks followed with his paper on the "Chemistry of Raw Water Ice," dealing especially with the agitation and, therefore, the volume of air required for different waters. The author had made a series of tests on the proper amount of agitation with the purpose of correlating the three factors: Size of can, temperature of brine and quantity of mineral salts in solution. The tabulated data showed that there was a direct relationship between the mineral salts in the water and the volume of air required, and extra agitation should be provided when the speed of freezing is increased. For a 300-lb. can of water containing 4 grains of solid matter per gallon 6.5 cu.ft. of air per minute were required. In the discussion it was shown that to compress this much air would require an excessive amount of power per ton of ice—so much more than was used in practice, that it was suggested the decimal point had been misplaced, the usual amount being much nearer 0.65 cu.ft.

Papers on "The Refrigerator Car—Retrospective and Prospective," by Eugene F. McPike and J. H. Bracken, both of Chicago, and their discussion ended the session.

The evening session, although not brimming over with information new or particularly instructive to the refrigerating engineer, was perhaps the most entertaining of all. C. H. Stevens, of the Brooklyn Edison Co., read his paper on "Electricity for Ice Making and Refrigeration as Supplied by the Central Station." In the early paragraphs the author had stated specifically that the paper would dwell principally on the question of rates. The audience was looking for just this information, but was doomed to disappointment. Mr. Stevens told them why their generating cost was lower than that of the isolated plant, the purchase of immense quantities of coal, its cheaper handling due to better facilities, and the high efficiency of the large units being the principal reasons. The cost of distribution was practically negligible as to a refrigerating plant current was transmitted directly at high voltage from the nearest generating station. As to profits these were extremely low. The central station could give low rates as the maximum refrigerating load came at the right time of the year to better their annual load factor. Systems of charging were explained and some useful tables were incorporated giving the power required for refrigerating and ice-making purposes, but not a word on rates, the information the audience was looking for and that which they had been led to expect by the author himself.

In the discussion C. G. Armstrong, of New York City, favored motors for small refrigerating plants but in most cases had not found the rates satisfactory. In the central station the operating cost was less, but this did not take into account the expensive selling force, the heavy transmission loss, the difficulty of transmitting the power from the

NOT CHEFS BUT MEMBERS OF THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS IN THE JUNGLE ROOM AT HEALY'S

motor to the compressor, and the probability of using exhaust steam for heating. There were cases where the power should be purchased but generally the isolated plant gave the best results. The whole question was not how the central station could do it, but for what they could sell current. As expressed by John E. Starr, it was a question of bargain and sale. Approximately 43.77 kw.-hr. were required per ton of refrigeration. Uptodate engineers of today are fairly well posted on the cost of an isolated plant, the extra labor required for firing, depreciation and fixed charges, etc. It is not a question of how, but what can the central station sell at?

Mr. Fairbanks of the Quincy Market Cold Storage & Warehouse Co., of Boston, said that this company had discussed the question of rates with the Edison Electric & Illuminating Co. The company has a peak load of 10,000 hp., mostly refrigeration and some power and lighting. For 24-hr. service the best rate they could obtain was 2c. per kw.-hr., and as they were already producing the same unit for ¾c. it was not deemed advisable to scrap their plant.

J. L. Plock referred to an ice plant in Brooklyn which was paying a 2½c. rate to the Edison Co. Adding fixed charges to this would sink the company on $2 ice. Charles H. Herter called attention to the 150-ton raw-water plant of the Bay Ridge Manufacturing Co., of Brooklyn, which was furnished power for the year at a minimum charge of $18,000, amounting to about 0.8c. per kw.-hr. This rate was explained by T. I. Jones, of the Brooklyn Edison, on the basis of the annual load factor. In January and December, that is at both ends of the year their output was maximum, and during the summer months there was a deep valley in the load curve. To fill this up with a load heavy in summer and light in winter was the aim of the company. The refrigerating plant had just this characteristic, so that the company could afford to dispense with the fixed charges and make a rate that would allow only a small profit on the operating cost. The company had a sliding scale of $80, $75 and $70 per kilowatt per year, and by dividing by the hours of service in each particular plant, it would be an easy matter to determine the rate per unit.

It was the consensus of opinion at the meeting that it was rather hard on the light and other power users to be forced to pay all of the fixed charges, and that the proposals made by Mr. Jones smacked of discrimination. Mr. Price, of the De La Vergne Machine Co. gave some data to the effect that an oil-engine plant could furnish power on 3½c. Mexican oil at 17c. per ton of ice, which with an allowance of $200 for lubrication would make the power charge at the Bay Ridge plant $7000 instead of the $18,000 charged by the Edison Co. The engine installation would cost $30,000 more, but with an annual saving of $11,000, the plant would pay for itself in three years and after that save $11,000 annually over Edison current.

An interesting talk by F. N. Speller on "The Manufacture of Pipe from Ore to the Finished Product," illustrated by moving pictures, was the feature of the evening session. The pictures were excellent and in following the metal from mine to pipe, gave a consecutive idea of the various processes that could never be obtained by a casual inspection of the mills.

In the fourth and last session on Tuesday morning, E. S. H. Baars' paper reviewed the feed systems of refrigerating coils and their respective advantages. Naturally the paper took up the three groups into which the various systems may be divided: The force feed or direct-expansion system, the gravity feed on flooded system and systems which are a combination of the two. This paper will be given further attention in an early issue.

J. C. Bertsch read a paper on "The Saturatic Cycle of Compression." In this cycle the vapor remains saturated throughout the entire operation. To prove that such a cycle is not only practical but the most efficient of all practical cycles, the author by means of simple entropy diagrams and tabulated data compared it with the purely theoretical Carnot cycle as well as with the wet, dry and strictly adiabatic systems. Severe criticism of the paper was made by Prof. L. S. Marks, of Harvard University. He objected to the term "Saturatic" and to the author's representation of the Carnot cycle. The efficiency of the Linde cycle as given was not correct and this put all the other cycles in error. The deductions for practical working were wholly gratuitous and the method of calculating the heat exchange in the walls of the compressor cylinder surrounded with ammonia was not in accordance with facts. The time of compression (about ⅛ sec.) was so short that there was no time to reduce the body of the gas to anywhere near the temperature of the cooling walls. An oral reply was not vouchsafed by the author, but a written discussion was promised in the near future.

"Defining the Heat Conductivity of Insulators," by Charles H. Herter, was the final paper, which was interesting and valuable as it compared the various methods of testing insulation now employed, the results obtained and incidentally showed that the formula most generally used for calculating the flow of heat through a wall or insulated surface overestimated the insulating value of nonconductors by 10 to 20 per cent. The author emphasized the difference between air and surface temperatures, showed the effect of air velocity and humidity, explained the construction of a temperature curve and in conclusion suggested a standard method of reporting conductivity tests in which all the data necessary would be included. A direct comparison would then be possible between different insulating mediums.

H. C. Dickinson of the Bureau of Standards stated that the Bureau had made a start in the testing of insulation. There were three factors to be considered; the heat conductivity of the insulation, heat transmission by convection and heat transmission by radiation. Tests as now conducted introduced these three indefinite factors and in attempting to obtain all of them at the same time error is sure to result. Two of the variables should be eliminated, convection and radiation, and it would then be easy to determine the conductivity of the material, which is really the factor that differentiates one type of insulation from another. The other factors could be determined afterwards by separate tests.

F. E. Matthews thought that the point of greatest importance was, what the insulation was going to do after it was installed. It was essential to first get the heat conductivity of the material itself, and this should be closely followed by the total conductivity of the installation, which would include surface resistance on which there was very little authentic data. A committee to coöperate with the Bureau of Standards was suggested and a motion to this effect passed, the appointment being left to the incoming president.

Mr. Dickinson was then called upon to explain the Bureau's method of testing. The apparatus consisted of three copper plates, about 8 in. square, in which were embedded sensitive thermo-couples to give the temperatures. Between the plates the insulation was placed and it was an easy matter to obtain the conductivity per unit of surface. The conductivity of air from thicknesses of 0.01 to 1 in. could also be obtained. In completing the discussion Mr. Herter explained his method of employing hot- and cold-water tanks with the insulation between.

Only a few minutes before adjournment one of the topical discussions on "Ammonia Purifiers or Regenerators," was started, but developed into a rather indefinite discussion on the temperature at which ammonia disintegrates.

The dinner in the evening in the Jungle Room at Healy's was an enjoyable event which helped to bond the ties of friendship and draw closer together the attending members of the society. John E. Starr was toastmaster and his selection was surely a happy choice. Speakers from the states of Washington, Utah, Illinois, Kentucky and on East to the Atlantic were listened to with interest, and of them all the eloquent address of Retiring President Neff will be remembered in years to come. His enthusiasm in the work of the society and sincere interest in the younger members were again in evidence and appreciated by the diners.

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Lecture on Lentz Engine

About 75 engineers listened to an interesting lecture on the Lentz engine and superheat, by Mr. McHose, of the Erie City Iron Works, before No. 3 Association, N. A. S. E., at Newark, N. J., Monday evening, Dec. 1.

Mr. McHose pointed out that poppet valves had long been used in marine practice where slow speeds prevailed, and that later in Germany, this type of valve was improved and adapted to high speeds. At present the Lentz engine, using poppet valves, is adapted to speeds up to 350 r.p.m.

To show the advantage of this type of valve over a Corliss valve for the same power engine, an illustration (lantern slide) was thrown on the screen, showing the relative sizes. The Corliss valve had six times as much rubbing surface and considerable additional weight, requiring more lubricating oil and more power to operate. It was pointed out that the poppet type of valve was much better adapted to high superheat, so essential to good economy.

Some interesting views of European power plants using Lentz engines were shown. The engines in one of these plants operate at 192 lb. pressure 270 deg. F. superheat and 26-in. vacuum. Views of locomotives; both industrial and express, using poppet valves were shown.

An illustration of an old Sulzer engine (a poppet-valve engine of German make) which, the speaker said, was imported in 1885 for a brewery was shown. Mr. McHose claimed that

the engine had been in almost constant service since its installation, and the valves have never been reground.

In the discussion which followed the lecture, Mr. McHose stated that no trouble was experienced in finding an oil to give good lubrication under very high superheats. He mentioned that there were many plants operating Lentz engines under 200 lb. absolute steam pressure and 200 deg. superheat, a total heat of

$$381.9 + 200 = 581 \text{ deg. F.}$$

A not uncommon practice in Germany, the speaker said, was to operate engines at 200 lb. steam pressure and 250 deg. F. superheat.

When the engineers for the Erie City Iron Works, licensed builders of the Lentz engine in the United States, visited Germany to investigate the Lentz engine, they found many industrial plants of about 100 hp. using highly superheated steam. Locomobiles using poppet valves were shown.

McIntosh & Seymour Corporation to Manufacture Diesel Engines

It is announced that a New York State charter has been granted to the McIntosh & Seymour Corporation, which will engage extensively in the manufacture of a complete line of stationary and marine Diesel engines. The company will be backed not only by large American interests, but also by Swedish capitalists who now control the Swedish Diesel Motor Co., which has a wide reputation as the builders of Diesel engines on the Hesselman system.

The new corporation will take over the plant and organization of the McIntosh & Seymour Co., of Auburn, N. Y., whose present steam-engine business will be continued.

The board of directors is composed of Marcus Wallenberg, president Stockholms Enskilda Bank, Stockholm, Sweden; Frank A. Vanderlip, president National City Bank, New York; Thatcher M. Brown, Brown Brothers & Co., New York; Edwin S. Church, Auburn, N. Y.; J. A. Seymour, Auburn, N. Y.; Franklin B. Kirkbride, New York City; Oscar Lamm, Stockholm, Sweden; Philip W. Henry, New York City. The general counsel is W. M. Coleman, New York City. Edwin S. Church, formerly superintendent of the Akron plant of the International Harvester Co., will be the executive head of the new corporation, and J. A. Seymour, president of the McIntosh & Seymour Co., will be the vice-president and in charge of engineering. The initial capitalization will be $2,200,000 and the stock one-half common and one-half 6 per cent. cumulative and participating preferred.

In 1898 the Swedish Motor Co. started building these engines. Many of the designs, as the fuel pump, the atomizer, details of pistons, etc., have been purchased and adopted by many other leading European builders of Diesel engines. Chief Engineer K. Jonas E. Hesselman has been knighted by the Swedish Crown in recognition of his distinguished achievements in this line.

The McIntosh & Seymour Co. in the past has been most successful in this country, and has a large export business.

It has for some time been commented upon, in view of the successful Diesel-engine business being done by many European concerns, that no attempt has been made in this country to build a full line of Diesel engines of a design which has proved to be a commercial success in actual use and where the actual cost of fuel oil is generally much lower than in Europe.

In addition to furnishing exclusive licenses for their valuable patents for the Western Hemisphere, the Swedish interests in the new American company insure their active aid and coöperation by furnishing a large part of the working capital, and furthermore, will take an active part in the actual building of the American engines. Mr. Wallenberg, the principal stockholder of the Swedish Motor Co., and Mr. Hesselman, the chief engineer, have been in this country investigating the situation, and the sizes and speeds desirable to conform to American standards and conditions.

National Conservation Congress

At its fifth annual session, held in Washington on Nov. 18, 19 and 20, the National Conservation Congress split into two factions over questions of grants of water power sites and control of water-power companies. The majority faction, led by Gifford Pinchot, father of the congress, adopted resolutions after three days of acrimonious debate, declaring that no grants of water-power sites should be made in perpetuity, while perhaps a hundred delegates who opposed this action and had urged that all powers of regulation be left in the hands of the states instead of the Federal government, left the convention and announced their purpose of calling a convention in the near future for the organization of a rival conservation association.

The states rights proposals were voted down, and the Pinchot resolution adopted by a vote of about three to one. The resolution which led to the breaking up of the convention in confusion, was as follows:

WHEREAS, concentrated monopolistic control of water power in private hands is swiftly increasing in the United States, and far more rapidly than public control thereof; and

WHEREAS, this concentration, if it is fostered, as in the past, by outright grants of public powers in perpetuity, will inevitably result in a highly monopolistic control of mechanical power, one of the bases of modern civilization, and a prime factor in the cost of living; therefore,

BE IT RESOLVED, that we recognize the firm and effective control of water power corporations as a pressing and immediate necessity urgently required in the public interest;

That we recognize that there is no restraint so complete, effective, and permanent as that which comes from firmly retained public ownership of the power site;

That it is, therefore, the solemn judgment of the Fifth National Conservation Congress that hereafter no water power now owned or controlled by the public should be sold, granted, or given away in perpetuity, or in any manner removed from the public ownership, which alone can give sound basis of assured and permanent control.

Opponents of the Pinchot ideas, which gave rise to the conservation movement during the Roosevelt administration, declared in the congress that up to the present time the whole movement had been one of "reservation" rather than conservation. Although the critics of the government's water power policy were in the minority in the congress, they were loud in their denunciation of the effects produced by the reservation of power sites from unrestricted development. The delegates who fought to reverse the present policies, and joined the secession ranks when they were beaten were almost wholly from western and southern states.

Three reports from the water-power committee, presented on the first day of the sessions of the congress, started the fight, which monopolized attention to the practical exclusion of consideration of forestry, which was on the program for the main topic of debate.

The minority report, upon which the Pinchot resolution was based, and which provoked the most criticism, was signed by Mr. Pinchot, Joseph N. Teal, of Oregon, and former Secretary of War Henry L. Stimson, of New York. Those who signed the majority report, which urged a more liberal policy in the granting of rights to water-power companies and apparently objected to the inclusion of certain statistics from the report of the commissioner of corporations, were George B. Swain, Lewis B. Stillwell, Marshall O. Leighton, Edwin S. Webster and B. M. Hall.

A general statement of the broad principles of conservation, upon which the committee was unanimous, was presented by Mr. Stimson, and was adopted by the convention without opposition. This summary proposed that no grants or leases of power sites should be made except under regulation, for the protection of the public interest at stake.

The minority report declared that the central fact and gravest danger in the waterpower situation is concentration of control. Ten groups of power interests, it asserted, control 65 per cent. of all the developed waterpower in the United States, and some of these groups are further related through interlocking directorates. While two years ago the ten largest groups of waterpower interests controlled but 3,270,000 hp. developed and undeveloped, it was declared, today the ten greatest groups control 6,270,000 hp., the amount of concentration toward monopoly having doubled in two years. Concentration in ownership of waterpower, it was said, has increased in five years about seven times faster then power development.

These facts, the report asserted, showed the fallacy of the charge frequently made that conservation has locked up water-power sites and prevented their acquisition for development. The waterpowers held by the ten greatest groups of power interests, developed and under construction, for the years 1911 and 1913, as compared with the undeveloped waterpowers held by the same interests, were shown to be as follows:

	1911	1913
Developed horsepower	1,821,000	2,711,000
Undeveloped horsepower	1,450,000	3,500,000

In refutation of the charge that the system of regulation under which the waterpower sites in the Forest Service are granted is stifling development, discouraging capital and holding back industry, the report showed that of the total waterpower development in the United States to date, nearly one-third has been developed or is licensed for development in the National forests, under government regulation.

"The fight for the conservation of the public waterpowers," the minority report asserted, "is first of all a fight against monopoly. But the second prime necessity in the public interest is to forbid and prevent the speculative holdings of powers unused, and to force the prompt and full de-

velopment of the vast aggregate of power resources now held idle and unproductive under concentrated private control. If we take the valuation of $45 per horsepower, the waterpowers now held undeveloped in the control of the ten great groups of interests, represent a total annual loss to the country of $160,000,000 worth of power.

The three essentials of a sound waterpower policy, declared the minority report, should be: (1) Prompt development; (2) Prevention of unregulated monopoly; (3) Good service and fair charges to the consumer. All interstate power business should be under Federal control and regulation, declared the report, as should also all development of waterpowers on navigable streams and those in the National Forests and the public domain. The minority report recommended that franchises for grants of power sites and power privileges under government regulation, should be made for not longer than fifty years, with the power in the hands of the government to revoke the franchise for cause at any time, and to revoke it at the discretion of the government after thirty years. Such franchises should be non-assignable and non-transferrable except with the consent of the government, and the government should participate in the profits of the operating companies above a fixed percentage on the investment, to be stated in the franchise. It was also proposed that in cases of waterpowers on navigable streams, the proceeds derived by the government should go to the improvement of navigation.

The majority report, presented by Professor Swain, of Harvard, was a lengthy document which referred briefly to the dangers of monopoly shown by the control of 65 per cent. of all the developed power in the country by ten groups of waterpower interests, and placed great emphasis upon the necessity for prompt development of water powers to encourage industry and conserve the coal supply. In order to encourage investment of private capital in waterpower enterprises, the Swain report proceeded, three essential features of a waterpower policy must be: (1) Definiteness in the contract entered into; (2) The prospect of a sufficiently attractive return, commensurate with the risk involved; (3) The protection of the courts in case of dispute.

In the case of navigable streams as pointed out by the majority report there are two conditions to be considered: Where the Government builds the dams to improve navigation and where the dams are built by private capital for the development of power. In the first case the waterpower is a byproduct of the navigation works and inasmuch as the Government has gone to the expense of building the dam, the grantee of the power permit should pay a reasonable compensation. In the second case, however, the Government may be benefited through greater navigability of the stream without expense to itself and the interests of conservation may be best served by making no charge, the improvement in navigation brought about by the construction of the dam and locks being accepted in lieu of charge. The Secretary of War should see to it, however, that the operation of the plant will not obstruct navigation.

The Swain report favored the granting of indeterminate franchises for power sites, subject to revocation only upon payment of the fair value of the property. Where application was made by states or subdivisions of states for indeterminate grants of power sites on navigable streams or in the public domain, the report proposed, the government should not exact a return.

The final paragraphs of the Swain report were the portion of the document which raised the clear issue between it and the minority.

"For the conservation of our waterpowers," these paragraphs asserted, "it is esential that capital should be attracted to these enterprises, and while we must, of course, fully protect the interests of the public, both present and future, we are not conservationists if we advocate the imposition of terms which restrict rather than encourage development. We must also remember that under present conditions waterpower investments are not especially attractive, and that steam power is a more desirable form of power, since it can be located where needed, and the supply regulated according to demand. Waterpower is more variable, and furthermore it requires, in general, a very much larger investment per horsepower than steam, though its running expenses are less. Because of the large first cost of water power developments the risk of loss in case of failure of the enterprise is correspondingly large. Capital, therefore, does not need waterpower enterprise, and it will not take them up to any considerable degree, unless fully protected.

"It has been estimated that we use annually over 480,000,000 tons of coal, worth nearly a billion dollars, in addition to many million dollars worth of other fuels; and that some $200,000,000 worth of this fuel might annually be saved by the utilization of waterpowers. When we consider also that the development of waterpower not only conserves fuel, but directly serves to promote the navigability of rivers, we should be very careful how we discourage this triple conservation in order to secure other results that we may consider desirable. If we do discourage it we may be anti-monopolists, or something else, but we are certainly not conservationists."

Pointing to the fact that Mr. Webster, who signed the majority report, is a member of one of the largest firms of water power promoters in the United States, Pinchot adherents declared that the majority report represented the special interests of waterpower promoters and exploiters, which it placed ahead of the public rights and interests in the subject. It was also freely charged that from some of the states, the delegations had been packed in the interests of private-power interests. Western and Southern delegates who opposed the declaration for Federal control, and finally seceded from the congress, retorted that the majority of the congress was controlled by former cabinet officers under Republican administrations, and had been packed with government employees by these former officials.

A resolution urged by Southern delegates, declaring that all waterpowers should be under exclusively state regulation, was voted down by about the same vote by which the Pinchot resolution was finally adopted.

One of the sensational features of the convention was the speech of Frank S. Washburn, president of the American Cyanamid Co., who charged Pinchot with being responsible for the veto of the Coosa River dam bill, and declared that this policy had driven from the United States a great industry. The Cyanamid company, he said, had been preparing to locate a plant on the Coosa river which would have cost millions of dollars, for the production of nitrogen from the air. The location of this plant would have built a city about it, given to the country a new industry, reduced cost of fertilizer and increased crop yields. When the Coosa river bill was vetoed, he said, his company located in Canada. Mr. Washburn, Senator Bankhead of Alabama, and other states-rights advocates, insisted that the Federal government should keep its hands off, and permit any regulation of power companies and rates to be exercised by the states, which would be more liberal in their policy, and would be more active in encouraging power development.

President Wilson and Secretary of State Bryan had been scheduled to speak at the congress, but did not put in appearance. It was unofficially said that they stayed away in order to keep out of the dispute between the advocates of state and Federal regulation. A political tinge was also given the convention by the fact that practically all the advocates of Federal regulation and ownership of power sites were officials formerly connected with Republican administrations, while Democratoc members of the Congress from Southern states led the minority fight for state regulation, and were leaders in the bolt from the congress.

An expected fight to have the congress take action in opposition to the proposed congressional grant of reservoir and power rights in the Hetch-Hetchy valley, to the city of San Francisco, did not materialize.

SOCIETY NOTES

The trustees of the American Museum of Safety will hold a safety and sanitation conference at Rumford Hall, in the Chemists' Building, 50 East Forty-first St., New York City, on the mornings and afternoons of Dec. 10, 11 and 12, in connection with the International Exposition of Safety and Sanitation. The sessions promise to be most valuable to those interested in welfare work of any sort. Many well known men and women will speak or lead discussion. The conference will afford unusual opportunities for learning recent developments in the present nation-wide movement for accident and disease prevention.

PERSONALS

A. G. Machesney, for 15 years traveling engineer and locomotive inspector with the Baldwin Locomotive Works, has become associated with the railway division of the Detroit Lubricator Co.